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CHEMISTRY.—*Some problems in attaining adequate nutrition.*[1]

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In observing the problems that arise in the feeding of large groups of men in the Army and in charitable and penal institutions, and contrasting these problems with those that are encountered in the feeding of farm animals, I have been impressed with the extent to which man's aesthetic reactions to foods handicap his nutritional status. Much of the malnutrition that exists both inside and outside of institutions, as well as the unrest, discontent, and low morale that lead to demonstrations, riots, and other disciplinary problems, is the result of man's unwillingness or inability to base the satisfaction of his appetite on his dietary needs and on the restriction of his purse.

Nutritional workers have calculated the needs of both men and farm animals and have determined by analyses which of the available food products contain the essential elements in forms suitable for use.

In farm animals the nutritional problem is fairly simple. Scientific investigators have drawn definite conclusions as the result of laboratory work with animals and feeds and have made definite recommendations. Feeds for animals are evaluated scientifically on the basis of their nutritional and economic factors. On such a basis farmers are able to work out feeding schedules for their livestock in a sound and economical manner. It would seem equally feasible and highly desirable to approach human nutritional problems in the same objective manner.

Man, however, uses food as a means of satisfying many emotional needs, which are so closely tied up with his physiological needs that unless they too are met he fails to get the most from his food. He enjoys and even demands variety, not only in foods themselves but in methods of preparing them. He wants foods that appeal to his eyes and his senses of taste and smell; he wants to eat in pleasant surroundings. Traditionally, partaking of food with other persons has been of such social importance that the emotional satisfaction derived from eating has often overshadowed the actual physiological

[1] Address of the retiring president of the Washington Academy of Sciences, delivered on January 19, 1939. Received July 8, 1939.

needs supplied by food. These factors greatly complicate the attainment of an adequate diet.

No really comprehensive treatment of nutrition is possible in the limited time available. Therefore, I have selected for discussion certain phases of human dietary habits and some of the possibilities and complications that arise in the practical application of our knowledge of foods and nutrition.

COMPLICATIONS IN HUMAN NUTRITION

Man's fundamental nutritive requirements, as determined experimentally, are usually expressed in terms of chemical compounds or complexes—proteins, fats, carbohydrates, etc.—of the foods commonly included in his diet. Until recently these compounds making up the major parts of the diet were the chief consideration. The importance of the vitamins and certain of the mineral elements required in small amounts is now being recognized. Some of these compounds are known only by the effects produced in the organism when they are absent from the diet.

The necessary quantities of the various foodstuffs vary with the size, age, and activity of the individual concerned and with the external conditions to which he is subjected.

The requirements for the various nutrients are seldom considered by man when arranging his diet. Instead, he thinks in terms of food—meat, potatoes, milk, salads. As the science of nutrition has progressed, it has been necessary to reevaluate foods as sources of the various nutrients and to indicate the uses of particular classes of foods in the diet. To make the best use of available foods in meeting the variety of tastes and habits in man, it is necessary to know the composition of foods, the variations in the composition of the same food, and changes that occur between harvesting and consumption. Furthermore, variations occur in the composition of different varieties of the same product and also as the result of maturity, climatic conditions, the fertility of the soil, and other factors.

The preservation and purification of foods add further complications. Natural foods contain some of almost all the necessary nutritive factors, although the quantities present may be so small that the food can not be considered an important source of that particular factor. The methods of preservation and purification used to keep foods from spoiling or losing quality or to make them more attractive often change the composition of the original food. Thus, there may be a reduction in certain constituents on drying or cooking, or a concentra-

tion of nutrients such as occurs in the manufacture of white flour, refined sugar, and polished rice. These changes create special nutritional problems when products of this type form the major part of a diet. The use of polished rice is a good example. In polishing rice the outer hull and the germ, which contain vitamin B_1, are removed, leaving the inner starch-rich endosperm. People who live largely on polished rice develop the nutritional deficiency disease known as beriberi. This can be corrected by feeding the rice polish itself or some other source of vitamin B_1. Once polished rice has been used it is very difficult to get people to accept unpolished or brown rice, in spite of its superior nutritive value. The use of refined products, however, is not objectionable in itself, but it necessitates careful selection of other foods if the diet is to be adequate.

To meet the various food habits and tastes of a cosmopolitan population it is important to popularize more than one source of each nutritive factor. Fluid milk, for example, is the standard source of calcium. The daily consumption of a quart of milk by a child or a pint by an adult is an assurance of an adequate calcium intake. But those who do not like or can not get fluid milk may substitute canned or dried milk, cheese, an extra amount of leafy vegetables, or even calcium salts and still meet their daily calcium requirements.

Carotene, one of the precursors of vitamin A, is chiefly responsible for the yellow color of vegetables and milk. Carotene is also present in the green leaves of plants, although masked by the green color. Any of the yellow or green vegetables, especially the leafy vegetables, or the yellow foods derived from animals, may be selected as a probable source of vitamin A.

An example of the value of substituting one food for another for economic reasons was shown some years ago by Dr. A. F. Hess. At a time when lime juice and lemon juice were the accepted sources of vitamin C, the antiscorbutic vitamin, Hess demonstrated the value of tomato and potato juice for treatment of scurvy in Negro children in New York. In this way he introduced antiscorbutic foods that were cheap and easily obtainable.

SIMPLIFYING SELECTION BY USE OF FOOD GROUPS

To simplify selection, foods that are somewhat similar in composition or are particularly valuable as a source of one or more nutrients may be grouped together. For example, meats, milk, and eggs are sources of protein of good quality; milk, the leafy vegetables, and dried legumes are sources of calcium; the green and yellow vegetables and

butter fat are sources of vitamin A and carotene; fruits and vegetables, especially the acid products, are sources of ascorbic acid; and lean meat, milk, and the leafy vegetables are sources of nicotinic acid, the antipellagra vitamin.

By using such knowledge, it is possible to express the nutritive requirements in terms of the quantities of the various types of foods for an adequate diet. A classified dietary of this kind has been used rather successfully as the basis of dietary control in the Federal penal institutions. An example is given in Table 1.

TABLE 1.—STANDARD RATION FOR FEDERAL PENAL INSTITUTIONS
(Expressed in pounds per man per day)

Food groups	Type food	General messes	Hospital messes
Meats	Beef.	.75	.50
Fats	Oleomargarine.	.15	.15
Flour, etc. Spaghetti, macaroni, rice, etc.	Flour, white.	.80	.80
Dairy products	Milk, fresh.[1]	1.00	2.00
Eggs	Eggs.	.03	.25
Sugar and syrup	Sugar, granulated.	.25	.25
Beverages	Coffee.	.10	.10
Potatoes Roots	Potatoes.	1.00	.80
Leafy green and yellow vegetables (including tomatoes 0.10 lb.)	Cabbage.[2]	.60	.50
Beans, dried, etc.	Beans, navy.	.10	.10
Fruits, fresh or canned	Apples.[2]	.15	.25
Fruits, dried	Prunes.	.08	.08
Miscellaneous	Yeast.	.015	.015
Spices, etc.	Salt.	.10	.10

[1] In reporting evaporated milk, dried milk, and cheese, they are converted to their equivalents of fresh milk.

[2] When a greater quantity of some other food than the type food in this group is used in a given month, it becomes the type food for purposes of estimating the cost of the ration.

In this ration the foods are grouped according to one or more of the following characteristics: (1) Similarity of nutritive value, (2) palatability, and (3) dissatisfaction when too large quantities are used.

The use of food groups simplifies the recommendation of diets, offers considerable opportunity for variety of choice, and permits an approximate evaluation of diets from different parts of the country that reflect wide variations in food habits.

The monthly "Mess House Operations" report used by the United States Department of Justice for each Federal penal institution shows the total quantity and average daily consumption for each food group calculated to the pounds consumed per man per day. Other data related to the cost of the various items and waste are reported. A calculation is also made of the cost of such a ration based on the price paid

for the type foods, reporting each food group as indicated in the preceding table.

A report of this kind is very useful in appraising the nutritional value of the food consumed and the economy of the expenditure for food in an institution. Such an analysis, combined with an examination of the menus, indicates the probable acceptability of the foods served, as well as the adequacy of the diet. A knowledge of the skill with which food is prepared and served in an institution is necessary for a complete understanding of the satisfaction derived from its operations. It is interesting to note that various institutions show individual food patterns characteristic of the region in which they are located. Furthermore, it is often possible to detect a change in stewards or in administrative control by shifts in the quantities of different foods used.

Reports of the kind just outlined should be as much a part of the records of all public institutions responsible for the care of men, women, or children as the financial reports. In fact, the justification for the expenditure of money in institutions, armies, or navies is to provide an adequate satisfactory diet. Without records of foods consumed, it is impossible to demonstrate the extent to which the expenditures have been properly made.

Dr. Hazel Stiebeling, of the Bureau of Home Economics of the United States Department of Agriculture, has successfully employed food groups in setting up dietary standards for persons of different ages and sexes at various levels of income or satisfaction.

USE OF THE MENU OR MEAL PLAN

When selecting or planning meals and reviewing dietaries, it is possible to use certain devices to test the adequacy of the diet or its probable acceptability, such as (1) by the quantities of each of the types or classes required, which has just been discussed, and (2) by a series of meal plans or menus. In reviewing dietaries, both kinds of information are needed if an indication of the probable acceptance of the diet is desired.

A menu may be considered as a plan by which foods are combined to make a satisfactory meal. By working out a series of menus a variety of foods and an adequate diet can be assured. Menus tend to follow patterns and are part of our food habits. Through the skillful planning of combinations of food, nutritive elements in which the diet was previously deficient may be added often without upsetting an accustomed routine. A large part of the success of this method of

changing food habits lies in maintaining interest in the meals from day to day. This is just as true for maintaining good dietary habits as for changing poor ones.

Although the immediate concern will be with the proper nutritive elements in the menu, many other factors enter into the contentment and satisfaction people obtain from meals, particularly the methods of service and the surroundings in which food is eaten. Interest in food through the menu or meal plan is attained by (1) the use of foods attractive in themselves, (2) changes in methods of preparation of foods, and (3) combinations of the foods into attractively prepared dishes. In the last-mentioned case the attractive characteristics of some foods, such as meats, sugars, etc., may be used to add interest to less attractive but necessary or useful foods such as the bland cereal grains or vegetables.

It is not enough to provide variety among the meals of one day. It is necessary also to prevent the monotony that follows the frequent repetition of foods or combination of foods, or the repetition of the same foods at regular intervals. This is evident from the difficulties that arise in feeding large groups of persons such as in college dining halls, army messes, and correctional institutions, particularly when the cooking is mediocre. Poor cooking and monotonous meals have been responsible for many riots. It is a matter of record that Harvard College was almost wrecked in its early days because of monotonous and inadequate meals.

The meal plan offers a very useful method of selecting a meal from a restaurant menu or cafeteria counter. For example, in selecting a dinner one might soliloquize as follows:

"Soup? A small portion, it's appetizing and not too filling.

"Meat? Yes, a steak—no animal protein so far today.

"Potatoes? Yes.

"Other vegetables? Broccoli, turnips, beets, or carrots? Make it broccoli and carrots, not enough vitamin A so far.

"Salad? Lettuce or fruit? Lettuce with Roquefort dressing—more carotene and more calcium.

"Dessert? Cottage pudding? No, calcium is still low, make it pumpkin pie, and a cup of coffee.

"Now, let's see, I had grapefruit this morning, tomato juice this noon, and broccoli, carrots, butter, and salad tonight to provide sufficient vitamins C and A. The meat, bread, my peanut-butter sandwich this noon, and cheese provide plenty of protein. The calcium may be a little low but the cheese and pumpkin pie have helped, and there was skim milk in the bread.

"The B factors? I have had only white bread, but there were meat, peanut butter, cheese, and vegetables to help out.

"There is plenty of iron, and by the time I fill up on bread and butter there will be enough calories."

The chances are, however, that someone else plans the meals that you eat and enjoy without questioning whether all the necessary nutrients have been supplied. Even the housewife may use ready-prepared menus. What training did the person who planned the meals have? How well was the planning done? If a pattern was followed, was the pattern good? Upon the housewife, dietitian, cook, or steward often rests the responsibility for inducing us to eat foods that are needed even though we may not like them. They should be trained at least in the general facts of nutrition and the possibilities of changing food habits. We look to them to plan meals that we can enjoy with the assurance that they are adequate as well as appetizing.

Although menus and meal plans are useful in attaining a good diet, they alone do not provide sufficient evidence by which to judge adequacy. Often diets appear inadequate when judged by the menus but are shown to be adequate by analyses of the quantities of foods consumed. Conversely, a similar analysis of interesting-looking menus may show an insufficient intake of important foods, especially vegetables.

PSYCHOLOGICAL RESPONSES INFLUENCING ACCEPTANCE OF FOODS

I have so far discussed food requirements and methods of checking the adequacy of diets and have touched only lightly upon attitudes toward food and the difficulties that sometimes interfere with the attainment of an adequate diet. Although there are complications, they arise because of man's intelligence. In modern civilization many people have gradually conditioned themselves to expect and even demand a much more complicated dietary than is needed to satisfy nutritional needs. This enjoyment is one of the privileges of man. Insofar as people can afford these habits, they should enjoy them. Enjoyment is, however, only relative. New opportunities arise and with them new desires are created. On the other hand, when enjoyment interferes with the acceptance of an adequate dietary, the individual is faced with the dilemma of continuing his habits or accepting something that appears to him to be less interesting and satisfying. These changes are more easily accepted by the individual than by groups of individuals.

Man likes what he is used to, but he also likes a change. On this premise it should be possible, under circumstances in which he is faced with the need for a correction in the dietary, to condition himself to a new set of habits.

In any attempt to improve the nutritional status of a person, there-

fore, use should be made of instincts, appetites, habits, and any other devices to condition him favorably to desirable food habits. Hunger and appetite can be made valuable aids in securing the acceptance of food. Hunger that is due to actual contractions of the stomach stimulates the seeking of food. Appetite, on the other hand, is associated with the presence, or even the memory, of pleasant odors and flavors of food and may occur when the stomach is full. When hunger contractions or pangs occur, people show irritability and restlessness, even when the attention is so occupied that the contractions are not recognized. When three meals a day are eaten at regular hours, hunger contractions are seldom noticed, and when only one or two meals a day are eaten a certain amount of indifference to them may be built up. Excitement, pain, or anger inhibits hunger; outdoor exercise, physical work, or insufficient food stimulates hunger and lowers the level of discrimination, thus creating a situation favorable to the acceptance of new foods, that may be utilized when there is need to change dietary habits.

As a matter of fact, people often take food as the result of appetite rather than of hunger. Appetite stimulates the flow of digestive juices but is not essential to the digestion of food, since once in the stomach, food is equally well digested whether liked or not, provided no serious or continuous emotional factors are involved.

Habit plays an important role in the acceptance, as well as refusal, of certain foods and is thus useful in efforts to provide an adequate dietary. Habits are paradoxes. A man will eat the same breakfast year in and year out but will rebel if his dinners or suppers are the same or even if they are repeated at weekly intervals. In New England hot baked beans are traditionally necessary for Saturday suppers and cold baked beans for Sunday breakfasts. In the South boiled beans are or were often a customary second dish for both dinner and supper, but in other parts of the country if beans are served two meals in succession there is likely to be trouble.

Man is not alone in the persistence of habit in the face of change. Animals accustomed to a particular ration do not readily change to another unfamiliar diet. For instance, a farmer in Ohio purchased some cattle raised in North Dakota that had never been fed corn, and it took some time to teach these cattle to eat corn. He reports that one steer never did acquire the habit of eating corn. Animals, however, show a greater willingness to consume the food presented to them than does man. They can also be taught to expect variety in their diets. These habits usually result from the tutelage of man and are

frequently seen in household pets, where their owners have projected their own conceptions of the pet's desire for variety or for particular foods.

Conditioning is another device that can be used to modify food habits. The classic experiment of Pavlov's dogs has led us to see how many of our actions, including attitudes toward food, are the result of conditioning or involuntary reactions to stimuli. Poffenberger favorably conditioned a group of students to music they did not like by playing it while they ate attractive meals. Most of us can explain an intense aversion to a particular food by its association with some painful event, or remember discovering that we "liked" a new food when it was eaten on a gala occasion. Conscious use of such methods of modifying established habits or creating acceptance of desirable foods offers a valuable means of improving dietary habits.

The role of instinct in determining the choice of foods is not certain, but some interesting examples of its effect on choice are reported. The new-born animal, born with a strong sucking instinct, having once found the nipple, soon learns to return to it with unerring accuracy. As it grows older it samples the various objects within its reach, learns that some foods are better than others, and builds up a standard of selection within the limits of food available.

An experiment with rats, conducted for the purpose of determining whether animals search for specific nutrients, indicated that the choice of a particular food was the result of a generalized search for food and that habit or conditioning played a part in its selection. Under experimental conditions rats have been found to choose a satisfactory diet from 11 relatively pure foods, including protein, carbohydrates, fat, certain vitamin-rich foods, and minerals, and to increase the consumption of sodium chloride or calcium where additional quantities of these elements were needed. Experiments with chicks showed that some of them consistently chose better diets than others.

Man's instinct or ability to select a satisfactory diet from among a number of foods or to modify the diet to meet changes in nutritive requirements has also been demonstrated. There is a careful report of three young children who were allowed complete freedom of choice from among a wide variety of natural foods over a long period of time. The diets selected met all their nutritive requirements and resulted in excellent growth. Normally, however, man's instinct is so overlaid by conditioning that he can not be trusted to select food with any relation to his physiological needs.

At present, sufficient evidence to determine the exact manner in

which the body recognizes nutritional deficiencies and determines the choice of food is lacking. One suggestion is that nutritional deficits cause physiological changes in the body and that these changes alter the taste mechanism and set up a craving for a specific food.

These nutritional facts and the attitudes of man to food may well serve as the basis for considering a problem that frequently defeats efforts to improve the nutritional status by setting up dietary standards. A survey of dietary habits indicates that there is still much to be done in bringing people to accept a diet that meets the caloric needs of the body and provides a liberal allowance of all the nutrients required. It is concerned with the maintenance of morale in men fed in groups, as in the Army and Navy, and the practical application of the newer knowledge of nutrition to the improvement of our national health and economic welfare. The difficulties involved become evident when an attempt is made to change the food habits of persons satisfied with a generous but nutritionally inadequate diet, to make drastic changes in the food of troops and yet maintain their morale, to set up a restricted though adequate diet for persons on relief, or even to understand the problems of the housewife who tries to stay within her food budget and still have a well-nourished and satisfied family. In each case the major problem lies in getting the persons concerned to accept the foods that should be used among those that are available.

Evidence has just been presented that indicates that young children and animals will select a fairly adequate diet if given a reasonable variety of natural foods from which to choose, or that they will seek other foods if the diet presented is inadequate. But as man grows older and develops fixed habits this faculty of selection of the diet is apparently submerged and seldom used. The desire for palatable or customary foods displaces the urge to search for foods that will make the diet more satisfactory from a nutritional standpoint.

VALUE OF EDUCATION AND TRAINING

The most promising solution of the problem of getting people to accept an available adequate diet lies in education and training. Training must begin with the establishment of good food habits in the child and involves learning to enjoy a simple adequate diet and to be willing to accept new foods to replace or supplement customary foods. The success of this program depends largely upon skill and attitude of the mother. Although education begins at home, it should be carried on also in the schools. Information given there reaches back into the home and affects the parents and other members of the family. Fi-

nally, there are great possibilities for general education for better dietary habits, particularly for adults. Here the problem is to insure the sound, broad presentation of facts, unbiased and in their proper relationships. Many books, bulletins, and pamphlets containing a large amount of information about nutrition are available for use in the home and school. Radio broadcasts and household publications offer advice and aid in planning meals. Many of these are biased; hence the information should be carefully evaluated before it is accepted. Great care must be taken to make sure that material to be used in the schools is factually accurate, that it presents completely unbiased discussions, and that it promotes no food product exclusively. Sometimes material is offered as educational that is really special pleading for particular food products. It may be well written, accurate, and informative. While manufacturers and industries are justified in advertising the merits of their products, this promotional material usually lacks the detachment and broad approach that should characterize educational material and should not be confused with it.

A considerable part of current popular material about food is presented in the form of recipes. This kind of material is very useful in securing the acceptance of new foods or the wider use of common foods. While recipes may be of little immediate interest to students of nutrition they are of real value to those who must prepare and serve meals. Since these persons should always consider foods in relation to their nutritive values and their place in the diet, material on preparation should present facts about the place of the foods in the dietary. An example of an excellent service of this kind is the weekly mimeographed press release called "The Market Basket," which the Department of Agriculture has issued for a long time. It has combined information on the general nutritive requirements of the family with information on seasonable foods and presents simple yet attractive methods of preparation.

As previously pointed out, material that is to be used as a guide either in teaching nutrition or in planning dietaries should suggest more than one major source of each of the nutrients. This is especially true if the material is to be used by people in all parts of the country and if people are to be taught the possibilities of varied diets.

The average person can hardly expect to keep well informed about all the changes in and additions to knowledge of man's food requirements, but he should realize the extent to which his food habits play a part in determining his well being. He should also realize that these are not infallible guides and that a nutritionally abundant and rea-

sonably satisfactory diet can be achieved at different income levels if one is willing to bring an open mind to its acceptance. If the housewife, steward, or cook can combine this knowledge with skill in the selection and preparation of food, real progress toward better nutrition can be made. Thus man can satisfy his body requirements for food without losing the opportunities to enjoy it.

BIOPHYSICS.—*Delayed killing of maize seeds x-rayed at liquid-air temperature.*[1] LOUIS R. MAXWELL, U. S. Bureau of Agricultural Chemistry and Engineering, and J. H. KEMPTEN, U. S. Bureau of Plant Industry.

The first stage in the biological response to x-rays is the absorption of quanta with the production of high-energy primary electrons. As these particles traverse the medium they lose their energy in the process of ion pair formation. On the average as each ion pair is formed there will be about 32 electron volts of energy taken from the primary electron. These early physical phenomena will be independent of temperature changes and will always provide discrete amounts of energy to the medium. The ion pairs formed will react with neighboring molecules and, since their energy is large compared with ordinary thermal reactions, these processes should not be dependent on temperature. These ionic reactions will then provide the initial energies of activation for subsequent low-energy, including thermal, reactions. The subsequent changes will be manifested by changes in the living plant. It is to be expected that many of these low-energy reactions will depend upon temperature changes. Any external influences, such as extreme variations of temperature, that will greatly affect any of these fundamental steps should prove to be a useful tool in the investigation of biological response to radiation with x-rays.

Maintaining the specimens at about −187°C. by means of liquid air during irradiation should largely eliminate significant thermal reactions within the material. The subsequent development of such specimens under normal growing conditions should give information as to the actual importance of thermal reactions during the time of irradiation. In the present experiments dry maize seeds were used because they are able to withstand submergence in liquid air without seriously altering their subsequent growth (9).[2]

Various experimenters have investigated the effects of small changes of temperature during the time of irradiation by x-rays. Early work

[1] Received May 24, 1939.
[2] Numbers in parentheses refer to the "Literature Cited."

by Muller (8) on *Drosophila melanogaster* and Stadler (10) on barley and maize showed no influence of temperature during irradiation on the observed mutation rates. As regards physiological changes (1) the temperatures used during irradiation have in general produced either no effect or else an increase in the amount of injury resulting from the irradiation as the temperature was raised. The literature on the genetic effect of x-rays has been summarized recently by Timoféeff-Ressovsky (12) and for plant cytogenetics by Goodspeed and Uber (5).

Crabtree (3) and Crabtree and Cramer (4) have shown that cold treatment renders cells more sensitive to radium radiation. This result has been confirmed by Mottram (7), who has shown that the growth of bean roots held at 0°C. during irradiation is much more adversely affected than when they are irradiated at 24°C. Apparently the temperatures used have not been below 0°C.

It has been found that under normal conditions maize seeds will respond to x-ray treatment in a very definite manner, which has been called "delayed killing" (2). An x-ray dosage of 70,000 *r* units for dry maize seeds will result, after normal germination, in complete delayed death as characterized by cessation of growth before the first leaf is fully exserted from the coleoptile. This type of response is obtained with certainty, and it was used in the present work as a criterion for detecting possible new developments arising from the use of liquid-air temperature.

EXPERIMENTAL PROCEDURE AND RESULTS

The experimental arrangement used is illustrated in Fig. 1. Directly beneath the x-ray tube was placed a large liquid-air flask in which a metal boat containing the maize seeds floated on the liquid air. The actual temperature was measured by means of a thermocouple embedded in one of the seeds, which showed that the seed temperature was not more than 2°C. above the temperature of the liquid air used (approximately −187°C.). Runs were made at room temperature under conditions identical with the liquid-air experiments by replacing the liquid air with water. This ensured that all secondary effects such as back scattering would be the same in both cases. After the x-ray exposures the seeds were brought up to room temperature within a few minutes.

A Coolidge air-cooled x-ray tube with tungsten anode was used at a constant potential of 45 k.v. This provided a continuous band of radiation with maximum intensity at approximately 0.50 Å. A sheet of black paper was used as a filter to eliminate heat radiation. The

anode distance was 23 cm, exposure time 5½ hours for 70,000 *r* units, and plate current 7 ma. Dosage values given were measured by means of a standard open-air ionization chamber (11) before and after each run. Dosage values given are accurate to within 5 percent.

Three treatments were given as follows: (*a*) 70,000 *r* units at liquid-air temperature, (*b*) 70,000 *r* units at room temperature, and (*c*) no

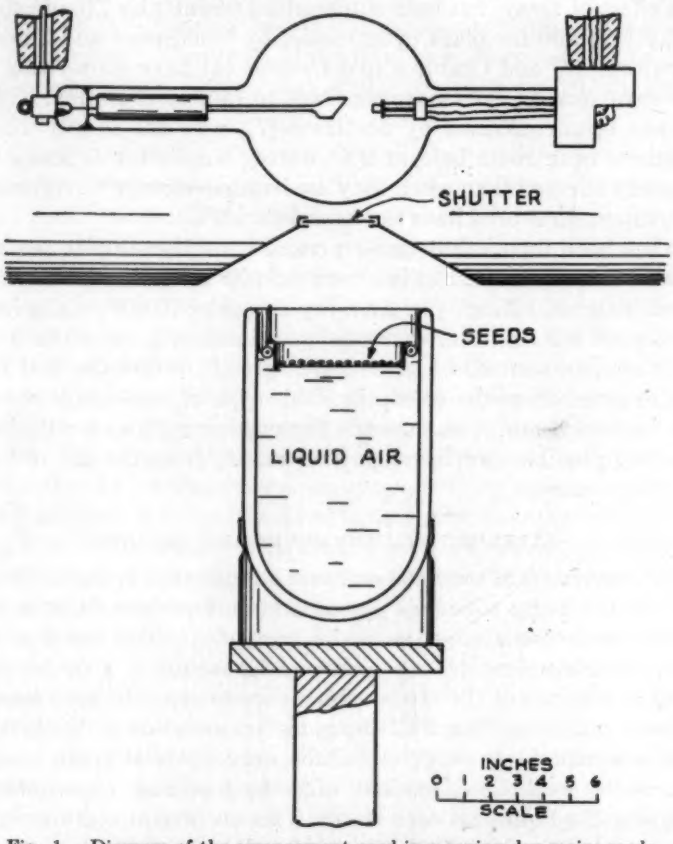

Fig. 1.—Diagram of the arrangement used in x-raying dry maize seeds at liquid-air temperature.

x-ray exposure but cold treatment at liquid-air temperature identical to (*a*). To this group was added a fourth lot as controls, which were kept at room temperature and were not irradiated.

In each of the treatments 300 seeds of Funk Yellow Dent maize were used. This seed was drawn from a thoroughly mixed commercial

stock that on testing had 8 percent moisture. This variety of maize has been used for several years in both x-ray and other radiation experiments and furnished the material on which the previous x-ray

Fig. 2.—Section of a seedling flat showing seedlings natural size from the four classes of treated seeds.

reports were based (2, 6). Experiments planned to disclose differential reactions of diverse types of maize to x-rays have been tried with negative results. It is believed, therefore, that the reactions obtained in the present experiment are general for maize seeds having no more than 8 percent moisture.

The three lots of treated seeds, together with the controls, were planted in the greenhouse in seven metal flats within a few days after

irradiation. These flats, 1 foot square and 4 inches deep, were designed to grow 12 rows of 12 plants each. The flats were filled to within one-half inch of the top with carefully mixed sterilized soil. After the seeds were planted points down and the crowns flush with the soil surface, the flats were filled level with the sides with water-washed sand. Thirty-six seeds from each treatment and the untreated control were planted in each of seven flats. With perfect germination this planting would provide 252 seedlings of each treatment. The position of the treatments within the four row blocks was random within each flat, and the flats were mounted on a compound clinostat where not only the table rotated but each flat rotated independently, thus eliminating between flats, and parts of flats, the effects of fixed shadows inevitable in greenhouse plantings.

Ten days after planting the heights of the seedlings were recorded in millimeters, the measurements being made from the box edges, not the soil surface. The plants were grown for another ten days to make certain there were no recoveries.

The results obtained show first that *delayed killing still occurs for the seeds held at liquid-air temperature during the time of irradiation*, as shown in Table 1 and illustrated in Fig. 2. However, within the x-rayed group the plants from seeds subjected to liquid-air temperature average 27 percent larger than those x-rayed at room temperature. The reverse of this is true for the plants from non-x-rayed seeds. In this latter case the plants from seeds cooled for 5½ hours at liquid-air temperature were 41 percent shorter than the controls. The difference in both cases is statistically significant as shown in the analysis of variance given in Table 2.

STATISTICAL TREATMENT OF RESULTS

Despite the precautions taken to ensure uniformity, the four row blocks differed among themselves more than would be expected from random variations. The variance of four row blocks was further subdivided into that contributed by differences between flats and that between the blocks within the flats. The ratios of the mean squares to the error mean squares show that the significant variability is between flats and not between the four row blocks within the flats.

The generalized error obtained from the entire experiment can not rightly be applied to the differences within x-ray treatments, because of the great disparity in size between the seedlings from x-rayed as compared with those from non-x-rayed seeds. However, the mean square for interaction shows conclusively that temperature and x-ray

treatment had a significant combined effect. To derive generalized errors for the x-rayed and non-x-rayed seeds the two populations were considered separately. Analyzing the variance for the group of seedlings from x-rayed seeds we see that the temperature at which the seeds are treated produces a significant effect and similarly within the non-x-rayed group temperature produces a significant effect. For the size populations under consideration the error of the difference between the two temperatures within the x-rayed group is 0.45 mm and in the group of seedlings from the non-x-rayed group it is 1.84 mm.

TABLE 1.—NUMBER AND MEAN HEIGHTS OF MAIZE SEEDLINGS SUBJECTED TO THE INDICATED TREATMENTS

Treatment	Number of plants	Mean height
		mm
70,000 *r*, liquid-air temperature	226	10.12 ± 0.30[1]
70,000 *r*, room temperature	239	7.97 ± 0.30
No x-ray, liquid-air temperature	240	77.35 ± 1.31[2]
No x-ray, room temperature	248	109.52 ± 1.29

[1] Error of the difference between the x-rayed groups = 0.45 mm.
[2] Error of the difference between the non-x-rayed groups = 1.84 mm.

TABLE 2.—ANALYSIS OF VARIANCE

Treatment	Complete experiment[1]		X-rayed seeds only[2]		Non-x-rayed seeds only[2]	
	Degrees of freedom	Mean square	Degrees of freedom	Mean square	Degrees of freedom	Mean square
Total	83	1,976.7	464	25.0	487	716.4
Four-row blocks	20	61.2				
Two-row blocks			20	33.0	20	1,508.8
Treatments	3	53,468.1	1	536.2	1	126,257.9
Error	60	40.7	443	23.5	466	413.0
Subdividing blocks:						
Flats	6	134.4	6	19.2	6	3,546.9
Within flats	14	29.8	14	38.9	14	635.3
Subdividing treatments:						
Temperature	1	4,680.1				
X-ray	1	149,607.4				
Interaction	1	6,116.7				

[1] Based on means of rows to avoid unequal frequencies.
[2] Based on individual plants.

DISCUSSION

It can be concluded first that delayed death does not result primarily from temperature-dependent thermochemical reactions, which might take place during the time of irradiation. However, when the

seeds are x-rayed at liquid-air temperature the extent of plant growth before death is greater than when they are irradiated at room temperature (approximately 21°C.). This would indicate that important destructive reactions that are involved in the phenomenon of delayed death can be retarded by holding the specimens at the temperature of liquid air during irradiation.

SUMMARY

1. The biological effect of x-rays is classified into essentially three stages:

(a) Absorption of quanta with liberation of primary electrons and subsequent ion-pair formation.
(b) Ion-pair reactions with the surrounding medium which are expected to be temperature independent involving chemical reactions which may require both low and high energies of activation.
(c) All subsequent low-energy, including thermal, reactions affecting the life of the material.

2. Maintaining seeds at liquid-air temperature during irradiation should greatly reduce the number of thermal reactions occurring at time of irradiation.

3. Delayed killing of maize seeds by x-rays is found to occur for a dosage of 70,000 *r* units when they are irradiated at liquid-air temperature (about −187°C.). Extent of growth of delayed killed plants at liquid-air temperature is significantly greater than for seeds irradiated at room temperature.

4. It is concluded that delayed killing of maize is not due primarily to temperature-dependent thermochemical reactions that might take place during time of irradiation. Factors producing delayed death are diminished by using liquid-air temperature during irradiation.

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BOTANY.—*A second United States species of* Bernardia.[1] C. V. MORTON, U. S. National Museum.

All the United States plants of the genus *Bernardia* (Euphorbiaceae) have been referred to a single species, *B. myricifolia* (Scheele) Wats., described from Texas on material collected by Lindheimer. Specimens collected in Arizona and California have, however, a somewhat different appearance, and a detailed examination has proved that they represent a distinct species. The western specimens have small leaves (rarely over 1.5 cm long) of an ashy color due to the very close, stellate pubescence, the individual hairs being so minute (hardly over 0.1 mm long) that they can be seen only with a rather high magnification. The under side of the leaves is so densely covered that none of the leaf surface itself is visible. On the other hand, the specimen of the type collection of *B. myricifolia* in the U. S. National Herbarium and all the numerous other Texas specimens have relatively larger leaves (often 4 or 5 cm long) and a longer and less dense pubescence, perhaps best described as stellate-hirsutulous. The rays of the hairs are 0.5 to 1 mm long, and the leaf surface is frequently visible. The stipules of the western plant are relatively conspicuous, owing to their blackish-purple color; those of *B. myricifolia* are inconspicuous, pale green or yellowish in color.

The stamens of the western plant are either 5 or 6 in number (or sometimes 7 according to Jepson), those of *B. myricifolia* twice as many (11 to 15). It is possible that there may also be a difference in the color of the connectives, those of *B. myricifolia* being dark purplish, those of the western plant apparently yellowish and of the same color as the anther cells. A further difference is observable in the styles, which are 3 in number, each once-parted. In *B. myricifolia* the lobes are conspicuously and complexly laciniate, but in the western specimens they are frequently quite entire or bear only one or two teeth on each side.

The western plant, here described as *Bernardia incana*, is quite common in Arizona but apparently rare in California. Its range does not overlap that of *B. myricifolia*, which in the United States is found only in Texas and New Mexico. In Mexico the ranges of the two are equally distinct, *B. myricifolia* being found in eastern Mexico (Coahuila and Tamaulipas), *B. incana* only in Lower California.

The only other species of this relationship that has ever been de-

[1] Published by permission of the Secretary of the Smithsonian Institution. Received May 4, 1939.

scribed is *Bernardia viridis* Millsp. from Lower California, the type of which has very kindly been lent by the University of California. This species was reduced to the synonymy of *B. myricifolia* by Standley, but it is evidently distinct. The material is inadequate for a complete diagnosis, but the relationship is decidedly with *B. myricifolia* rather than with *B. incana*.

It should be mentioned that both Jepson and Munz state that *B. myricifolia* (i.e., *B. incana*) is monoecious. I have examined a good many specimens carefully with this in mind but have never found both sexes on the same specimen, although both are often on the same herbarium sheet.

Bernardia incana Morton, sp. nov.

Frutex dioicus; folia alterna bistipulata, stipulis crassis cucullatis atropurpureis persistentibus; lamina foliorum oblonga, 10–15 (raro 25) mm longa, crenata, subtus cinerea, dense incano-puberula, pilis stellatis minutis pluriradiatis; pedicelli masculi graciles, sepalis 3 minutis, externe minute puberulis; stamina 5–7, antheris flavis, connectivo concolore; flores feminei solitarii vel bini, sessiles, segmentis 5 imbricatis, externe minute puberulis; styli 3 bipartiti, lobis integris vel dentes 1 vel 2 utroque latere gerentibus.

A much-branched, thorny, dioecious shrub, the stems terete, glabrate except at apex; leaves alternate, congested at the tips of short lateral branchlets, bistipulate, the stipules elongate-triangular, 1 mm long or less, cucullate, thick, blackish purple, externally puberulous, persistent; petioles short, terete, up to 4 mm long, about 0.5 mm in diameter, densely short-puberulous; leaf blades oblong, up to 25 mm long and 12 mm wide, rounded at apex, obtuse at base, regularly crenate, the crenations 4–6 on each side, subcoriaceous, subtrinerved at base, pale green above, cinereous beneath, densely short incano-puberulous beneath, the hairs stellate with many (about 10) rays, these not over 0.13 mm long, about 10μ wide; staminate inflorescence up to 15 mm long, axillary, the rhachis slender, densely puberulous, the bracts 4–6, minute, each subtending a fascicle of 3 or 4 flowers, the pedicels 2–2.5 mm long, very slender, often nearly glabrous; staminate perianth of three sepals, these free, ovate, about 1 mm long, valvate, acutish, pale yellow, externally puberulous; stamens 5 or 6 (or rarely 7), the filaments about 0.5 mm long, glabrous, the anthers yellow, suborbicular, about 0.25 mm long, the connective pale; rudimentary ovary none; pistillate flowers solitary or in pairs, sessile, the perianth segments 5, about 2 mm long, imbricate, the innermost linear; disk low, trigonal; ovary stellate-puberulous; styles 3, two-cleft, the branches simple or with 1 or 2 short lobes on either side; capsule about 6 mm high, 9 mm wide, densely cinereous-puberulous, the hairs stellate, similar to those of the lower leaf surface; seeds subglobose, pale brown, about 6 mm long, ecarunculate.

Type in the U. S. National Herbarium, no. 59822, collected at Sierra Tucson, Ariz., April 21, 1884, by C. G. Pringle.

ADDITIONAL SPECIMENS EXAMINED:

Arizona: Fish Creek, *McKelvey* 1110; *Peebles, Harrison, & Kearney* 5348. Sierra Estrella, *Peebles, Harrison, & Kearney* 3292. Superstition Mountain, *Gillespie* 8606. Lowell, *Parish* s. n. Bright Angel Trail, Grand Canyon,

Leiberg 5953; *Goldman* 2225; *Coville* 1690, 1695; *Eastwood* 1. Pipe Creek, Grand Canyon, *Goldman* 2246. Congress Junction, *M. E. Jones* s. n.

California: Whitewater, *Parish* 752. Without special locality, *Parry & Lemmon* 375.

Lower California: San Pablo, *Purpus* 27.

PALEOBOTANY.—*A* Meliosma *in the Wilcox Eocene.*[1] EDWARD W. BERRY, Johns Hopkins University.

Many years ago Professor Newberry described a leaf that he christened *Viburnum cuneatum*[2] from the Eocene of Tongue River in Montana. This was ultimately figured in his posthumous monograph.[3] Newberry was very uncertain about this generic reference, and, as the specimen had none of the features of *Viburnum*, when I found what appeared to be identical forms in the Holly Springs sand of western Tennessee I reviewed a large amount of recent material and came to the conclusion that its affinities were with the Hamamelidaceae and transferred it to the genus *Parrotia* of that family.[4] Some years later better material was collected in Arkansas.[5]

I have been on the lookout for comparable recent material ever since and some years ago concluded that my earlier comparison with *Parrotia* was a mistake and that what it really represented was a species of *Meliosma.*

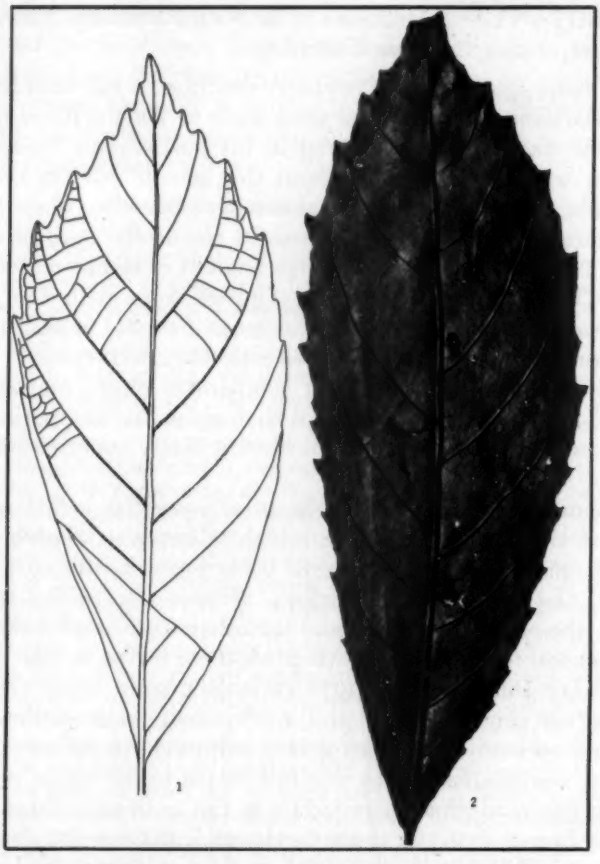
The genus *Meliosma* of Blume comprises more than half the existing species of the family Sabiaceae, which is hence a relatively small family, tropical or subtropical in its occurrence, mostly north of the Equator, and Asiatic and American. *Meliosma* is divided into two sections, the one with pinnate and the other with simple leaves.

The general features that distinguish these leaves is their obovate form; rather shiny firm texture; variable margin, either entire or when toothed generally entire in the lower half, when toothed rather irregularly so both as to spacing and emphasis; prominent primary venation; secondaries in the toothed forms indifferently craspedodrome or camptodrome, some ending in the teeth and others sending a tertiary branch into the teeth; tertiaries sometimes simple and percurrent, at other times connected by zigzag connections midway between adjacent secondaries. The whole venation facies is rather characteristic and readily recognizable, but difficult to describe.

The lower Eocene Montana-Wilcox form should be called *Meliosma*

[1] Received May 2, 1939.
[2] NEWBERRY, J. S. Proc. U. S. Nat. Mus. 5: 511. 1883.
[3] NEWBERRY, J. S. Mon. U. S. Geol. Surv. 35: 130, pl. 57, fig. 2. 1898.
[4] BERRY, E. W. U. S. Geol. Surv. Prof. Paper 91: 219. 1916.
[5] BERRY, E. W. *Ibid.* 156: 71, pl. 12, fig. 10. 1930.

cuneata (Newberry). (See Fig. 1.) Its closest living analogues occur for the most part in Mexico and Central America. In general there is less close a resemblance to existing species in the Antilles, which are mostly entire; and those of eastern Asia, which are generally slenderer



Figs. 1, 2.—1, *Meliosma cuneata* (Newberry), Wilcox Eocene. 2, *Meliosma dentata* Urban, from Central America.

and have more regularity of dentition, although several of the latter are more like the Montana example than they are like the Wilcox forms.

It is among the variable leaves of *Meliosma dentata* Urban and *Meliosma glabrata* (Liebm.) Urban of Central America that the fossil

form can be most closely matched. The leaf of the former shown in Fig. 2 is not nearly so like the fossil as others of that species which I was unable to obtain for illustrating.

The fossil record of *Meliosma* is very incomplete, largely, I believe, because paleobotanists have been relatively ignorant of the foliar characters of some of the tropical families. The present Wilcox species is the oldest known leaf specimen, although Reid and Chandler[6] have described three species based on endocarps from the London clay of southeastern England (Sheppey), which is almost exactly the same age as the Wilcox (Ypresian). There is also a fruit from the Pliocene of Reuver and Swalmen[7] in Holland, which completes the known European records.

The additional American records include a fruit described by the present writer[8] from the lower Miocene of California and three species based upon leaves described by Chaney and Sanborn[9] from the upper Eocene Goshen flora of Oregon. One of these—*Meliosma goshenensis* Chaney and Sanborn[10]—is the most similar to the Wilcox species. These authors compare this species particularly with the existing *Meliosma panamensis* Standley, although calling attention to certain similarities in the living Chinese *M. rigida* S. & Z. and *M. simplicifolia* Roxb.

ZOOLOGY.—*A new allocreadiid trematode,* Podocotyle shawi, *n. sp., from the silver salmon.*[1] ALLEN MCINTOSH, U. S. Bureau of Animal Industry.

The species described in this paper is based on 5 specimens that were recently forwarded for identification to the Bureau of Animal Industry by Dr. J. N. Shaw, Oregon State Agricultural College, Corvallis, Oreg. This species belongs to the genus *Podocotyle,* but since it does not appear to agree with any known member of the genus, it is regarded as new and is described below.

Podocotyle shawi, n. sp.

Description.—Body elongated, 4.1 mm long by about 1.1 mm wide, slightly constricted at equator, broadest at region of testes, anterior end more attenuated than posterior end; cuticula without spines. Oral sucker terminal, 310μ by 250μ; cuticula of inner wall of oral sucker appearing as if

[6] REID and CHANDLER. *London clay flora, British Museum.* 1933.
[7] C. and E. M. Reid. *Pliocene flora of the Dutch Prussian border,* p. 113, pl. 11, figs. 19–21, 24, 25. 1915.
[8] BERRY, E. W. Journ. Washington Acad. Sci. 19: 99, figs. 1, 2. 1929.
[9] CHANEY and SANBORN. Carnegie Inst. Washington Publ. 439: 84. 1933.
[10] *Ibid.* 84, pl. 28, figs. 2, 3; pl. 29, figs. 1–3.
[1] Received March 8, 1939.

provided with rasplike scales. Acetabulum pre-equatorial, 500μ by 450μ. Prepharynx about 150μ by 150μ; pharynx 200μ in diameter; esophagus 400μ by 50μ; intestinal crura ending near posterior end of body. Excretory pore at posterior end of body, opening into an elongated bladder. Testes from ovoid to almost spherical in outline, tandem and contiguous, situated in posterior half of body; anterior testis 380μ by 600μ, posterior testis 450μ by 550μ. Cirrus sac 1.7 mm long by about 100μ wide, extending along median line from near region of ovary, bending to pass acetabulum laterally to area

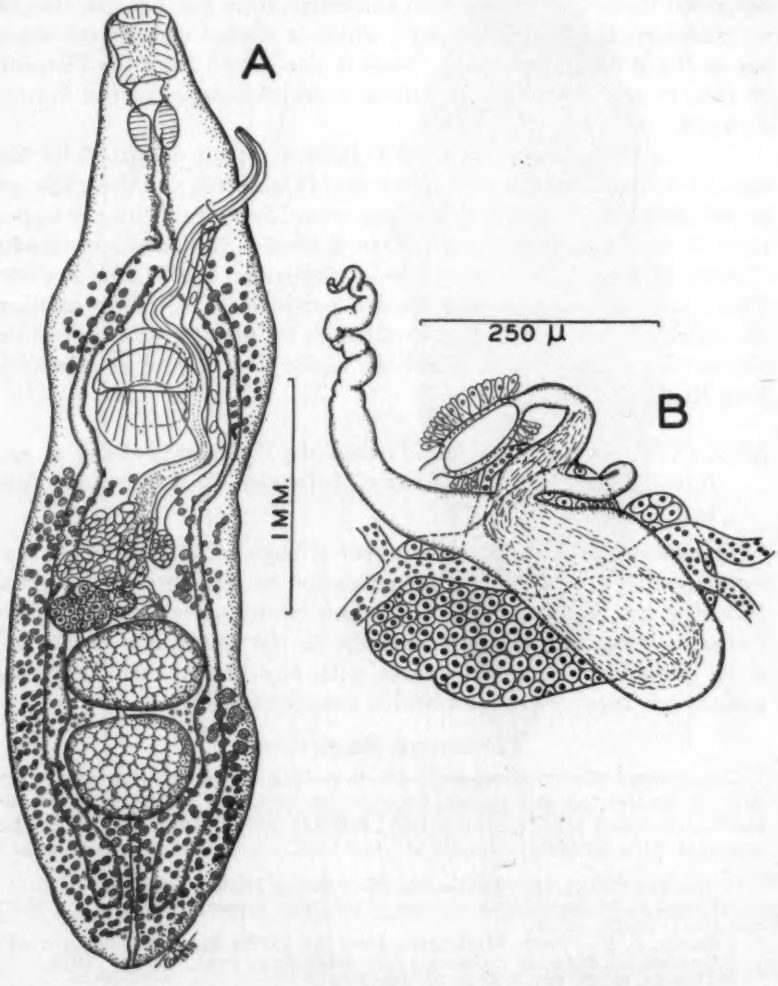


Fig. 1.—*Podocotyle shawi*, n. sp. A, Ventral aspect. B, Ovarian complex, dorsal aspect.

between acetabulum and cecal fork and then continuing diagonally to genital pore; cirrus spiny, protruding in type specimen beyond body margin. Genital pore located laterally about halfway between median line and margin of body in zone of posterior third of esophagus. Ovary lobed, 200μ by 380μ, median or lateral in position, pretesticular. Seminal receptacle dorsal to ovary, about 150 to 300μ; Laurer's canal extending anteriorly from large seminal receptacle. Vitellaria extending from level of intestinal fork to beyond cecal tips, usually with an interruption at basal level of acetabulum. Uterus between ovary and acetabulum, consisting of few coils. Metraterm elongated, to left of cirrus sac. Eggs about 78μ by 55μ, yellowish brown.

Habitat.—Intestine of silver salmon, *Oncorhynchus kisutch* (Walbaum).

Distribution.—Alsea River, Oregon, U. S. A.

Specimens.—U. S. N. M. Helm. Coll. nos. 43427 (type) and 43428 (paratypes).

Remarks.—In addition to the type specimens from *Oncorhynchus kisutch* there are several specimens in the Helminthological Collection of the Bureau of Animal Industry from the cutthroat trout (*Salmo clarkii* Richardson) and the steelhead trout (*Salmo gairdnerii* Richardson) that apppear to be identical with the specimens on which the new species is based; these specimens were also collected by Dr. Shaw from the same locality.

Podocotyle shawi differs from most of the other members of the genus in that the vitellaria on each side extend in front of the acetabulum to the level of the cecal fork. In a few species of the genus *Podocotyle*, namely, *P. atomon* var. *dispar* Nicoll, 1919, *P. lanceolata* Price, 1934, and *P. pennelli* Leiper and Atkinson, 1914, some few vitelline follicles, usually only on the right side, are present in front of the acetabulum; however, in these three species the cirrus sac is short in comparison with the elongated cirrus sac of *P. shawi*.

Recent contributions to our knowledge of the genus *Podoctyle* are to be found in papers by Price, 1934 (Smithsonian Misc. Coll. **91**: 1–8); McFarland, 1936 (Journ. Biol. Board Canada **2**: 335–347); and Park, 1937 (Journ. Parasit. **23**: 405–422). In the last-named paper a key to the species of the genus *Podocotyle* is given.

ENTOMOLOGY.—*A key to the larval Bostrichidae in the United States National Museum (Coleoptera).*[1] WILLIAM H. ANDERSON, U. S. Bureau of Entomology and Plant Quarantine. (Communicated by C. F. W. MUESEBECK.)

Twenty-one species are included in the accompanying key, which deals only with full-grown or nearly full-grown larvae. Twenty of the species are represented in the larval collection of the United States National Museum. The only species treated of which no larvae are contained in that collection is the cosmopolitan *Rhizopertha dominica* (F.), the distinguishing characters of which have been taken from the valuable paper by Gardner.[2] Except for *Dexicrates robustus* (Blanch.), all the species in the key occur in North America.

The family characters of larval Bostrichidae have been given in detail by Böving[3] and will not be repeated here. However, the scope of the family is here extended to include the Psoidae of Böving and Craighead.[4] The genera comprising this family, namely *Stephanopachys*, *Rhizopertha*, *Dinoderus*, *Polycaon*, and *Psoa*, were excluded from the Bostrichidae by those authors because they possess strong epipharyngeal sclerotization, a large pseudomolar process, and large fleshy lacinia mandibulae. That these characters are hardly sufficient for family separation was brought out by Gardner (l. c.), who showed that the larval mandible of the Bostrichini has a small fleshy appendage (lacinia mandibulae) and a small rodlike projection (pseudomola). Furthermore, although in habitus the imagoes of the Psoinae are somewhat divergent from those of the Bostrichinae, those of the Dinoderinae must be considered convergent. And a study of the larvae of Psoinae and Dinoderinae indicates the close relationship between the subfamilies. In addition, the biologies of the Psoinae and Dinoderinae are very similar to those of the Bostrichinae. It seems best, therefore, to include the Psoidae of Böving and Craighead in the Bostrichidae.

I agree with Gardner (l. c.) and Lesne[5] in considering *Dinoderus* and related genera (Dinoderinae) sufficiently distinct from the Psoinae to be worthy of subfamily rank. In the Dinoderinae the anterior

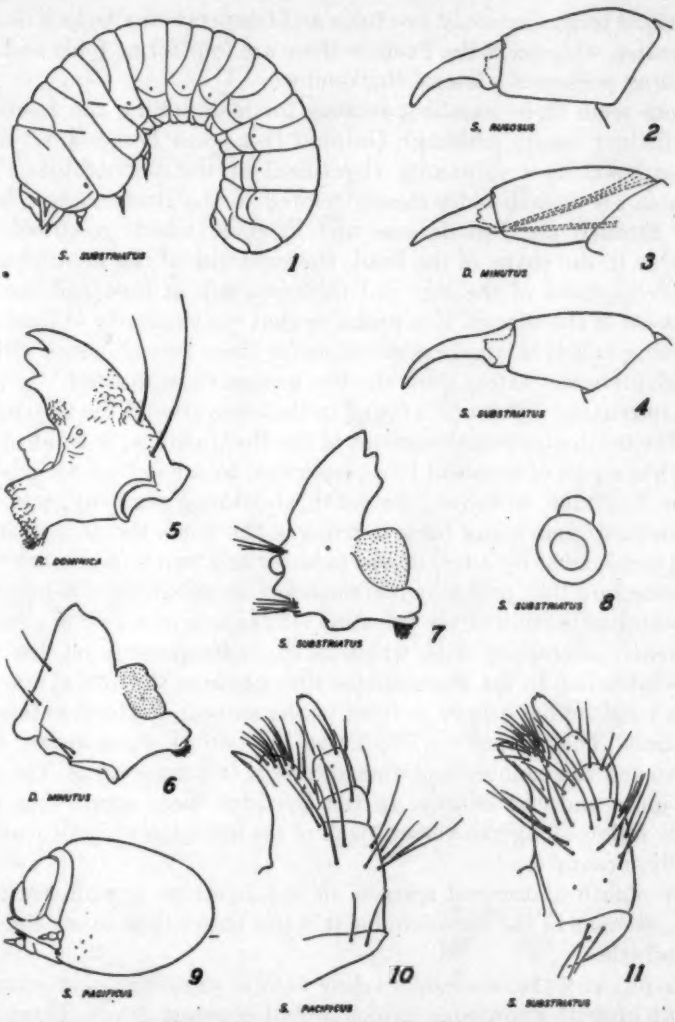
[1] Received March 22, 1939.

[2] GARDNER, J. C. M. *Immature stages of Indian Coleoptera (15) (Bostrychidae).* Indian Forest Rec., Ent. Ser. 18 (9): 1–19, 4 pls. 1933.

[3] BÖVING, ADAM G. *Tazonomy and morphology of the larval stages of* Scobicia declivis (*Lec.*). U. S. Dept. Agr. Bull. 1107 (appendix): 49–56, pls. 1–2. 1922.

[4] BÖVING, ADAM G., and CRAIGHEAD, F. C. *An illustrated synopsis of the principal larval forms of the order Coleoptera.* Ent. Amer. 11 (n.s.): 1–341, 125 pls. 1931.

[5] LESNE, PIERRE. *Les coléopières bostrychides de l'Afrique Tropicale Française.* Paris, 288 pp., 210 figs. 1924.



Figs. 1–11.—1, *Stephanopachys substriatus* (Payk.), lateral view (body setae omitted). 2, *S. rugosus* (Oliv.), tibiotarsus and claw, left prothoracic leg (setae omitted). 3, *Dinoderus minutus* (F.), tibiotarus and claw, left prothoracic leg (setae omitted). 4, *Stephanopachys substriatus*, tibiotarsus and claw, left prothoracic leg (setae omitted). 5, *Rhizopertha dominica* (F.), right mandible, dorsal view (adapted from Gardner, *l. c.*, fig. 34). 6, *Dinoderus minutus*, left mandible, dorsal view. 7, *Stephanopachys substriatus*, left mandible, dorsal view. 8, *S. substriatus*, spiracle from third abdominal segment. 9, *S. pacificus* Csy., head, dorsolateral view (setae, for the most part, omitted). 10, *S. pacificus*, left maxilla, ventral view. 11, *S. substriatus*, left maxilla, ventral view. Except for Fig. 5, all drawings are by the author.

abdominal terga have only two folds and the prothorax lacks a lateral thickening, whereas in the Psoinae there are four tergal folds and the prothorax possesses a lateral thickening.

There seem to be excellent reasons for maintaining the Lyctidae as a distinct family, although Gardner (l. c.) and Lesne (l. c.) have treated them as a subfamily (Lyctinae) of the Bostrichidae. The Lyctidae are undoubtedly closely related to the Bostrichidae, especially through the Dinoderinae and Psoinae, which resemble the Lyctidae in the shape of the head, the structure of the mouth parts, the development of the legs and their position at rest, and the enlargement of the thorax. It is probable that the similarity of food and of feeding habits is largely responsible for these resemblances. Other, less adaptive characters show the two groups to be distinct.

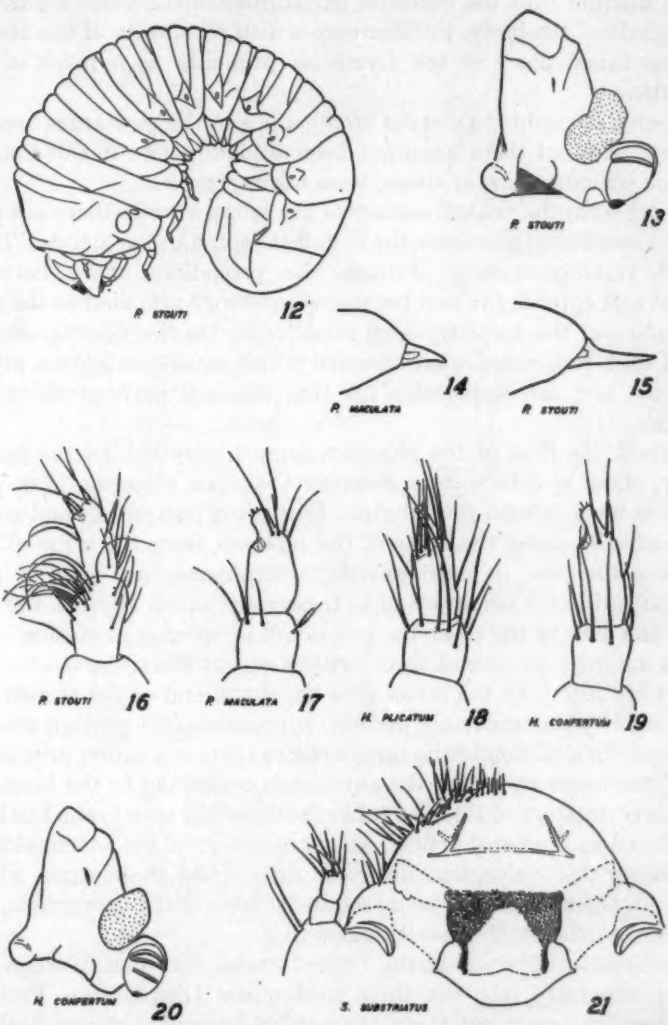
An important difference is found in the lobes around the anal opening. The tenth abdominal segment of the Bostrichidae, in front of the anus, has a pair of adjacent lobes separated by a longitudinal groove. In the Lyctidae, however, the tenth abdominal segment lacks the longitudinal groove and folds in front of the anus, the anal opening being surrounded by a transverse anterior and two lateral lobes.

A structure that probably has considerable significance is found in the posterior portion of the intestine. It consists of a pair of slender, apparently sclerotized rods, which lie in, or inseparably on, the wall of the intestine. In the Bostrichidae they begin at the lateral margins of the longitudinal groove in front of the anus and extend anteriorly in spirals. The spirals run clockwise for two or three turns, then reverse and run counterclockwise for one or two more turns. The rods then unite and end blindly. In the Lyctidae these supporting rods simply follow along the ventral wall of the intestine without winding spirally, around it.

The eighth abdominal spiracle in the Lyctidae is comparatively huge, whereas in the Bostrichidae it is not larger than other abdominal spiracles.

The pupae of the two families show little of significance, interpreted by our present knowledge, which would separate them. There is a difference in the habitus that is in agreement with the habital difference between the imagoes, the Lyctidae being usually more strongly depressed and less compact.

There is a significant difference in the male genitalia of the two families. In the Bostrichidae the axis of the aedeagus is parallel to that of the body. The genitalia of the Lyctidae, on the other hand, are somewhat asymmetrical in that the sclerotized parts are curved in



Figs. 12–21.—12, *Polycaon stouti* (Lec.), lateral view (body setae omitted). 13, *P. stouti*, right mandible, buccal view. 14, *Psoa maculata* (Lec.), tarsal claw, right prothoracic leg. 15, *Polycaon stouti*, tarsal claw, right prothoracic leg. 16, *P. stouti*, antenna. 17, *Psoa maculata*, antenna. 18, *Heterarthron plicatum* (Lec.), antenna. 19, *H. confertum* (Lec.), antenna. 20, *H. confertum*, right mandible, buccal view. 21, *Stephanopachys substriatus*, epipharynx. All drawings by the author.

such a manner that the posterior extremities of the lobes are not in the midline of the body. Furthermore a distinct torsion of the aedeagus has taken place in the Lyctidae, probably as a result of the curvation.

It seems advisable to discuss briefly a few of the structures used in the key. Some of them have not been studied before in this family, and one structure has, at times, been misinterpreted.

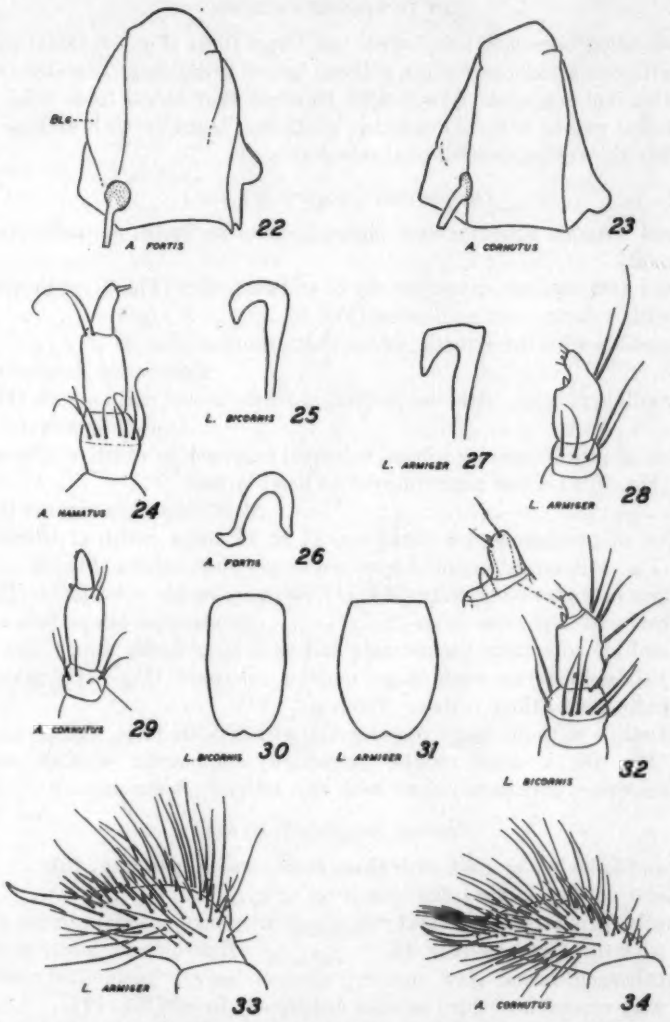
Arising from the ventral surface of the labral sclerite there is a pair of stout sclerotized processes, the so-called "epipharyngeal rods." They extend vertroposteriorly through the pocketlike space between labrum and epipharynx and become secondarily attached to the dorsal surface of the epipharyngeal membrane. On the ventroposterior end of each rod, muscles are inserted which usually originate within the head and are responsible for the principal movements of the labrum.

Beneath the floor of the pharynx, immediately behind the buccal cavity, there is a forwardly directed U-shaped sclerome (Fig. 43). This has been termed the fulcrum. Extending posteriorly and somewhat dorsally along the walls of the pharynx from the arms of this sclerome there is, in most species, a supplementary pair of rods (Fig. 38). Muscles are attached to these rods[6] which assist in the tilting of the floor of the pharynx, and hence in opening or closing it.

The antenna consists of three articles except when the second and third have fused. In the latter case the distal end of the second can be located by the uniformly present, supplementary, conical, sensory appendix. In addition to the three articles there is a rather prominent basal membrane by which the antenna is connected to the head. By some investigators of this and other families this membrane has been considered as the basal article. An examination of the antennal muscles shows this conception incorrect since, from their origin within the head, the muscles can be traced to the base of the first article, and are not inserted on the membranous ring.

The bostrichid larvae in the United States National Museum are readily separable into the three subfamilies Dinoderinae, Psoinae, and Bostrichinae. That these are natural groups is shown both by larval characteristics and by the structure of the male genitalia.

[6] It is, of course, impossible to consider these rods as being, as Pringle stated, "upwardly directed into the mouth cavity." PRINGLE, J. A. *Observations on certain wood-boring Coleoptera occurring in South Africa.* Trans. Roy. Ent. Soc. London 87 (11): 247–270, 1 pl., 5 figs. 1938.



Figs. 22–34.—22, *Apatides fortis* (Lec.), left mandible, buccal view (BLG, dorsal bulge). 23, *Amphicerus cornutus* (Pallas), left mandible, buccal view. 24, *A. hamatus* (F.), antenna. 25, *Lichenophanes bicornis* (Web.), epipharyngeal rod, lateral view. 26, *Apatides fortis*, epipharyngeal rod, lateral view. 27, *Lichenophanes armiger* (Lec.), epipharyngeal rod, lateral view. 28, *L. armiger*, antenna. 29, *Amphicerus cornutus*, antenna. 30, *Lichenophanes bicornis*, outline of foramen. 31, *L. armiger*, outline of foramen. 32, *L. bicornis*, antenna. 33, *L. armiger*, tibiotarsus and claw, left prothoracic leg. 34, *Amphicerus cornutus*, tibiotarsus and claw, left prothoracic leg. All drawings by the author.

KEY TO SPECIES STUDIED

1. Abdominal segments 1 to 5 with two tergal folds (Fig. 1); labial palpus with one article; prothorax without lateral thickening (Dinoderinae).2
   Abdominal segments 1 to 5 with three or four tergal folds (Fig. 12); labial palpus with two articles; prothorax laterally with oblique rodlike thickening or with oval raised area.....6

Dinoderinae (couplets 2–5 inc.)

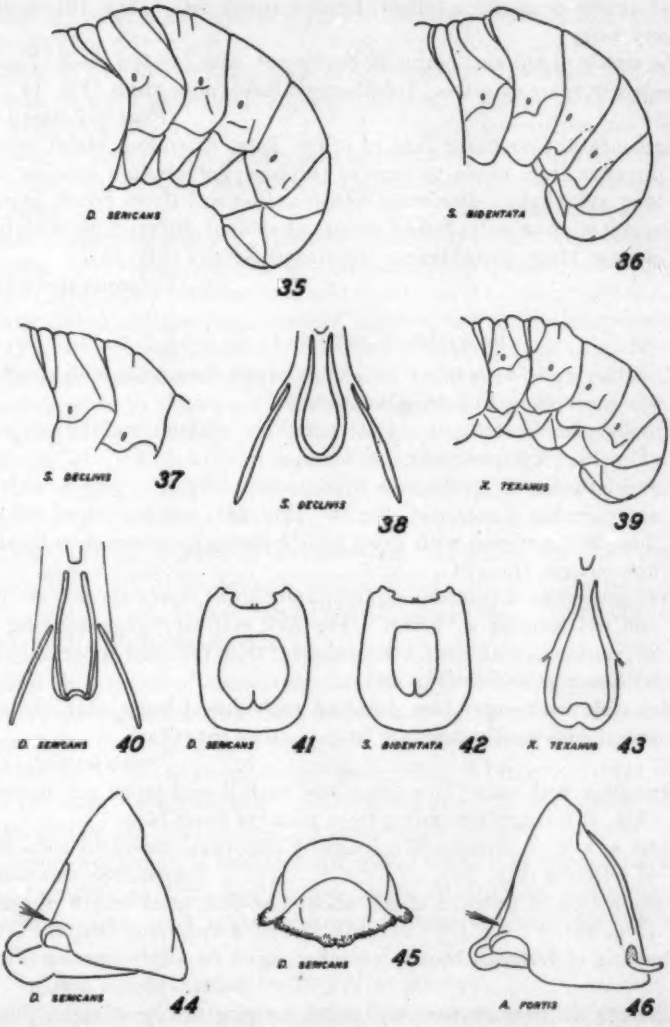
2. Head without subcutaneous pigment spots or ocelli; spiracles simple, oval.....3
   Head with pigment spots (usually 5) and an ocellus (Fig. 9); each spiracle with a dorsal oval projection (Fig. 8).....4
3. Mandible with three teeth; molar part granular (Fig. 5).....
   .....*Rhizopertha dominica* (F.)
   Mandible oblique, with one projecting tooth; molar part smooth (Fig. 6)
   .....*Dinoderus minutus* (F.)
4. Claw of prothoracic leg robust, subequal in length to width of tibiotarsus (Fig. 2)[7]; ventral pigment spot of head largest.....
   .....*Stephanopachys rugosus* (Oliv.)
   Claw of prothoracic leg slenderer, 1¼ to 1½ times width of tibiotarsus (Fig. 4); ventral pigment spot not larger than others (Fig. 9).....5
5. Stipes with numerous setae (Fig. 11). *Stephanopachys substriatus* (Payk.)
   Stipes with few setae (Fig. 10).....*Stephanopachys pacificus* Csy.
6. Mandible with large pseudomola and with large fleshy appendage (Fig. 13); epipharynx with large median sclerome (Fig. 21); maxillary palpus with three articles (Psoinae).....7
   Mandible without large pseudomola, either with (Fig. 46) or without (Fig. 44) a small rodlike projection; epipharynx without median sclerome; maxillary palpus with two articles (Bostrichinae).....11

Psoinae (couplets 7–10 inc.)

7. Mandibular molar part with three transverse ridges (Fig. 20).....8
   Molar part with one transverse ridge (Fig. 13).....9
8. Prothoracic tarsal claw stout; clypeus lightly pigmented; antenna clearly with three articles (Fig. 18).....*Heterarthron plicatum* (Lec.)
   Prothoracic tarsal claw slender; clypeus heavily pigmented; antenna with second and third articles apparently fused (Fig. 19).....
   .....*Heterarthron*[8] *confertum* (Lec.)

[7] The tarsal claw of bostrichid larvae has been considered immovably united with the tibiotarsus. In certain species (cf. Fig. 3) that have been investigated in this study the full quota of muscles is present and extends from the claw into tibiotarsus and femur. It seems logical, therefore, that the claw is independently movable.

[8] The use of *Heterarthron* in place of *Polycaon* for these two species seems justified, since they are not congeneric with *Polycaon stouti* (Lec.). *Lichenophanes bicornis* (Web.) has been used in place of *Bostrichus bicornis* (Web.) because *bicornis* appears congeneric with *L. armiger* (Lec.). Lesne has expressed these same opinions in his recent catalogue; Lesne P. Bostrychidae, in *Coleopterorum catalogus* (W. Junk) 10 (161). 1938.



Figs. 35–46.—35, *Dendrobiella sericans* (Lec.), posterior half of abdomen. 36, *Scobicia bidentata* (Horn), posterior half of abdomen. 37, *S. declivis* (Lec.), fifth and sixth abdominal terga. 38, *S. declivis*, pharyngeal fulcrum. 39, *Xylobiops texanus* (Horn), posterior half of abdomen. 40, *Dendrobiella sericans*, pharyngeal fulcrum. 41, *D. sericans*, head capsule, ventral view. 42, *Scobicia bidentata*, head capsule, ventral view. 43. *Xylobiops texanus*, pharyngeal fulcrum. 44. *Dendrobiella sericans*, left mandible, dorsal view. 45, *D. sericans*, tip of abdomen, posterior view. 46, *Apatides fortis*, left mandible, dorsal view. All drawings by the author.

9. First article of antenna robust, bearing many setae (Fig. 16); mentum very hairy 10
   First article of antenna normally developed, with but few setae (Fig. 17); mentum sparsely setose; [prothoracic tarsal claw stout (Fig. 14)] ..... *Psoa maculata* (Lec.)
10. Pigmentation on outer face of stipes long, extending about one-half distance from cardo to base of palpiger; submentum bearing many long, silky hairs .. *Dexicrates robustus* (Blanch.) (from South America)
    Pigmentation on outer face of stipes not evident; submentum with fewer, shorter hairs; [prothoracic tarsal claw slender (Fig. 15)] ..... *Polycaon stouti* (Lec.)

Bostrichinae (couplets 11–20 inc.)

11. Maxillary mala with freely projecting stylet; mandible with small rodlike projection (Fig. 46) (Bostrichini) 12
    Maxillary mala without stylet; mandible without rodlike projection (Fig. 44) (Xyloperthini) 16
12. Terminal setae of prothoracic tibiotarsus subequal in length with claw and forming a compact "brush" (Fig. 34); epipharyngeal rod short (Fig. 26); antenna with third article distinct, subequal in length to first article (Fig. 24) 13
    Terminal setae of prothoracic tibiotarsus stout, much shorter than claw and not forming a "brush" (Fig. 33); epipharyngeal rod long (Fig. 25); antenna with third article shorter than first and apparently fused with second article (Fig. 28) 15
13. Mandible with outer face dull and with dorsal bulge (Fig. 22, BLG.) prominent, gently receding from plane of inner face ..... *Apatides fortis* (Lec.)
    Mandible with outer face shiny and with dorsal bulge not prominent (Fig. 23), sharply receding from plane of inner face 14
14. First article of antenna long, slightly less than one-third total length of antenna (Fig. 24) ..... *Amphicerus hamatus* (F.)
    First article of antenna short, about one-fifth total length of antenna (Fig. 29) ..... *Amphicerus cornutus* (Pallas)
15. Opening of foramen broad, lateral margins smoothly curved (Fig. 31) ..... *Lichenophanes armiger* (Lec.)
    Opening of foramen narrow, lateral margins nearly straight (Fig. 30) ..... *Lichenophanes bicornis* (Web.)
16. Tarsal claw cleft; antenna shorter than maxillary palpus; mandible oblique, pointed ..... *Dinapate wrighti* Horn
    Tarsal claw simple; antenna longer than maxillary palpus; mandible gouge-shaped 17
17. Posterior extensions from pharyngeal fulcrum not developed as pigmented rods (Fig. 43) 18

Posterior extensions from pharyngeal fulcrum developed as pigmented rods (Fig. 38) 19

18. Claws on second and third pairs of legs pigmented; scutum and scutellum of sixth abdominal segment forming a conspicuous transverse ridge (Fig. 39) ..... *Xylobiops texanus* (Horn)

Claws on second and third pairs of legs not pigmented; scutum and scutellum of sixth abdominal segment not forming a conspicuous ridge ..... *Xylobiops basillaris* (Say)

19. Sixth abdominal segment, dorsally, divided into two transverse areas (Fig. 36); lateral margins of foramen straight, nearly parallel (Fig. 42); anal lobes prominent 20

Sixth abdominal segment, dorsally, divided into three transverse areas (Fig. 35); lateral margins of foramen strongly curved (Fig. 41); anal lobes less prominent (Fig. 45) ..... *Dendrobiella sericans* (Lec.)

20. Scutum of sixth abdominal segment prominent (Fig. 36) ..... *Scobicia bidentata* (Horn)

Scutum of sixth abdominal segment not prominent (Fig. 37) ..... *Scobicia declivis* (Lec.)

ENTOMOLOGY.—*New ichneumon-flies parasitic on the hemlock sawfly* (Neodiprion tsugae *Middleton*).[1] R. A. CUSHMAN, U. S. Bureau of Entomology and Plant Quarantine. (Communicated by C. F. W. MUESEBECK.)

Recent outbreaks of conifer-feeding sawflies of the genera *Diprion* and *Neodiprion*, both introduced and native species, have greatly increased the interest in and economic significance of the parasites of such insects. This has resulted in the rearing of large numbers of the parasites, many representing undescribed species, for which names are desired for use in economic and biological papers.

This paper consists of the descriptions of eight new species parasitic on the hemlock sawfly, *Neodiprion tsugae* Middleton, together with a few taxonomic and nomenclatorial notes pertinent to the main subject.

Genus **Ischnus** Gravenhorst

Ischnus Gravenhorst, Ichneumonologica Europaea **1**: 638. 1829.—Viereck, U. S. Nat. Mus. Bull. **83**: 78. 1914.

Habrocryptus Thomson, Opuscula entomologica, fasc. **5**: 471, 498. 1873.—Schmiedeknecht, Opuscula ichneumonologica, fasc. **7**: 502. 1904.

This is the *Ischnus* of the genotype, *porrectorius* (F.), not the phaeogenine genus *Ischnus* of European works. To it should be referred the following North American species:

[1] Received May 20, 1939.

Ischnus amblytelarius (Provancher), n. comb.

Cryptus amblytelarius Provancher, Additions et corrections au volume II de la faune entomologique du Canada . . . p. 70. 1886.

Ischnus atricollaris (Walsh), n. comb.

Cryptus atricollaris Walsh, Trans. St. Louis Acad. Sci. **3**: 72. 1873.

Ischnus polychrosidis (Cushman), n. comb.

Spilocryptus polychrosidis Cushman, Proc. U. S. Nat. Mus. **53**: 461. 1917.

Ischnus oregonensis, n. sp.

From the foregoing three species this species is easily distinguished by its entirely impunctate abdomen and distinctly convex (in front view) cheeks. Also the thorax never has any ferruginous color, although the propodeum is rarely partly piceous.

Female.—Length 6–8 mm (holotype 8 mm).

Head mat; temples strongly receding, convex; frons with a narrow, shining, median groove, scrobes also shining; eyes slightly divergent below antennae; clypeus strongly convex, small, shining; cheeks in front view convex; malar space as long as basal width of mandible; antenna distinctly shorter than body, 31-jointed, slender, filiform, first joint of flagellum nearly 6 times as long as thick, second only slightly shorter.

Thorax mat; pronotum mostly striato-rugulose; mesoscutum, scutellum, and pleura minutely punctate, the scutum and pleura confluently so, speculum polished; propodeum finely rugulose, dorsal face short, posterior face nearly vertical, transverse carinae distinct, apical carina sometimes obsolete medially but strong at angles; sides of areolet distinctly convergent toward radius, but their upper ends rather widely separated.

Abdomen granularly mat, impunctate, only the petiole dorsally shining; sheath of ovipositor about a half longer than first segment.

Black, with abdomen and legs ferruginous, front coxa and sometimes others more or less piceous, hind tibia (except base) and tarsus fuscous; anterior orbit and short streaks behind and above eye and a triangular spot in malar space whitish; labrum whitish; clypeus and mandibles piceous; palpi and flagellum fuscous; collar and usually a narrow humeral margin of pronotum whitish; tegulae brown; propodeum sometimes more or less reddish posteriorly (in holotype there is a streak of this color along median portion of apical carina); wings subhyaline, venation black.

Male.—Length 6–7 mm.

Much slenderer than female, with propodeum more evenly rounded and less precipitous and with weak carinae; genital sheath abruptly very slender apically. Head and thorax copiously white-marked, this color including face, clypeus, mandibles, palpi, malar space, broad orbital ring (interrupted only behind top of eye), underside of scape, ventral portion of propleuron, broad collar and humeral margin of pronotum, median spot on mesoscutum, scutellum, tegula, subalar tubercle, spots on lower mesopleuron, metapleuron and center of propodeum, front and middle coxae and trochanters, and a spot dorsally on hind coxa; hind coxa and basal joint of trochanter piceous; wings hyaline; petiole and apex of abdomen black.

Host.—*Neodiprion tsugae* Middleton.

Type locality.—Sweet Home, Oreg.

Holotype, allotype, and *paratypes.*—U.S.N.M. no. 53343.

Paratypes.—Canadian National Collection; California Academy of Sciences.

Thirteen females and 18 males (including holotype female and allotype male, a mated pair), all reared at the type locality from *Neodiprion tsugae* under N. E. For. Ins. Lab. no. 51.201, during June and October; 2 ♀ and 5 ♂ reared from type host at type locality under Hopk. U. S. nos. 31607-S, 31660-F, and 18875-F, during May, August, and September; 1 ♀ and 1 ♂, West Yellowstone, Mont., from sawfly on lodge-pole pine, Hopk. U. S. nos. 18088-F, Aug. 13, 1926 (♀), 18088-E, 1925 (♂); and 1 ♂, West Yellowstone, Mont., Hopk. U. S. no. 17243-B, April 9, 1925.

Spilocryptus neodiprionis, n. sp.

From *Spilocryptus lophyri* (Norton), which is also parasitic on species of the genus *Neodiprion,* this species can be distinguished at once, in the female, by the entire lack of yellow markings on the head and thorax, and in the male by the black face and orbits, only the clypeus and mandibles being white, whereas in *lophyri* the orbits, and in the male, usually the middle of the face, are white-marked.

Female.—Length 5.5–8 mm (holotype 8 mm).

Head mat, face densely and postvertex more sparsely punctate, frons medially rugulose, lower cheeks polished; temples very strongly receding, weakly convex; clypeus strongly convex, shining; malar space about as long as basal width of mandible; antenna three-fourths as long as body, 26- to 27-jointed, slender, filiform, first joint of flagellum six times as long as thick at apex, subapical joints definitely longer than thick.

Thorax dorsally shining, mesothorax densely and finely punctate and scutellum sparsely so; pronotum mostly striate; mesopleuron and metapleuron finely rugulose, mat; sternum shining, finely punctate; propodeum more coarsely rugulose than pleura; apical carina rather prominent laterally, broadly interrupted medially; sides of areolet slightly convergent, recurrent at or slightly beyond middle of areolet.

Abdomen very minutely coriaceous, with minute scattered punctures on basal tergites and with rather dense and very fine appressed silvery pubescence; first tergite impunctate and glabrous dorsally, the petiole polished; sheath of ovipositor barely longer than first segment.

Black, with basal three abdominal segments and legs ferruginous; a median spot on tergite 7 and usually an incomplete annulus centering on flagellar joints 7–8 white; antenna reddish fuscous, scape redder; tegulae piceous; hind femur apically and tibia dorsally blackish; wings subhyaline, venation black.

Male.—Length 5.5–7 mm.

More slender than female and with propodeum more evenly rounded because of much weaker apical carina; clypeus, mandibles, palpi, and tegulae whitish; antenna without trace of annulus; legs paler, especially front and middle coxae and trochanters and joints 2–4 of hind tarsus, the tarsus otherwise darker than in female; tergites 4 and 5 also ferruginous, some or all of the red tergites frequently more or less spotted or banded at base with black; tergite 7 without white spot.

Host.—*Neodiprion tsugae* Middleton.

Type locality.—Sweet Home, Oreg.

Holotype, allotype, and *paratypes.*—U.S.N.M. no. 53344.

Paratypes.—Canadian National Collection; California Academy of Sciences.

Described from 27 females and 29 males all reared from the host in April, May, June, and October 1936, under N. E. For. Ins. Lab. no. 51.201. Included are five mated pairs, identified by the added number 36.2, of which the holotype female and allotype male are one pair.

Unlike most species of the genus, this lacks the conspicuous white annulus at the base of the hind tibia.

Aptesis (Pezoporus) tsugae, n. sp.

Unusual in the form of the areolet, which is nearly parallel-sided.

Female.—Length 5–8.5 mm (holotype 8.5 mm).

Head narrower than thorax, finely coriaceous, somewhat shining; temples convex, receding; vertex and frons medially grooved; scrobes shallow, subpolished; eyes divergent below, antennae not far above inferior tangent of eyes; face with a small, round, median elevation; clypeus small, strongly convex, apically truncate; malar space as long as basal width of mandible; antenna about two-thirds as long as body, stout filiform, 25- to 27-jointed, first joint of flagellum slightly shorter than second and about two and a half times as long as thick.

Thorax stout; pronotum mat, finely striato-coriaceous; mesoscutum shining and faintly punctate laterally, densely and finely punctate medially, notaulices fine and distinct anteriorly; scutellum polished, sparsely punctate; mesopleuron shining, indefinitely coriaceous and sparsely and weakly punctate, fovea very deep; sternum shining and sparsely punctate; metapleuron mat, finely coriaceous; propodeum short dorsally, precipitous and concave posteriorly, basal area and areola confluent, basal carina obsolete, apical strong, basal lateral and petiolar areas coriaceous, surface elsewhere rugulose; legs moderately stout; areolet nearly parallel-sided, second intercubitus mostly bullate, second recurrent slightly before middle of areolet; nervulus slightly postfurcal, postnervulus broken nearly at middle; nervellus broken near bottom and strongly inclivous.

Abdomen broad, coriaceous, mat; sheath of ovipositor about as long as first segment.

Black; inner orbits, a more or less definite incomplete annulus on flagellar joints 7–9, tegulae, wing radices, and a more or less distinct line on humeral margin of pronotum white or whitish; face medially, and clypeus and mandibles more or less, reddish; antenna apically and ventrally reddish; thorax black, sometimes piceous or ferruginous laterally and ventrally; legs ferruginous; wings hyaline, venation blackish; abdomen normally black, with reddish tinge, especially at apices of tergites, but frequently more definitely reddish especially on tergites 1–3.

Male.—Length 5.5–7 mm (allotype 6.5 mm).

Much more slender than female, with antenna tapering and nearly as long as body, joint 1 of flagellum distinctly longer than 2 and three times as long as thick; malar space much shorter than basal width of mandible; eyes parallel; antenna not far below middle of eye; propodeum longer above and shorter behind, with petiolar area more sloping and more weakly concave.

Color as in female, but with less tendency to red on thorax and abdomen; antennae entirely black; white markings more extensive, including face, clypeus, mandibles, palpi, and front and middle coxae and trochanters; hind coxa and trochanter piceous, apically whitish; hind tibia apically and tarsus blackish.

Host.—*Neodiprion tsugae* Middleton.

Type locality.—Sweet Home, Oreg.

Holotype, allotype, and *paratypes.*—U.S.N.M. no. 53345.

Paratypes.—Canadian National Collection; California Academy of Sciences.

Thirty-six females and 33 males, all from the type locality and all reared from *Neodiprion tsugae,* 30 females and 31 males under N. E. For. Ins. Lab. no. 51.201. Included in this series are five mated pairs, of which the holotype female and allotype male are one pair. The other 6 females and 2 males were reared under Hopk. U. S. nos. 31607–204, 31660-V, 31660-Q, and 31675-V.

Genus **Thysiotorus** Foerster

In his *Type species of the genera of ichneumon flies*[2] Viereck designated, as the type of *Thysiotorus* Foerster, *Hemiteles* (*Physiotorus*) *brevipennis* Brischke, assuming Brischke's spelling of the subgeneric name to be a typographical error.

The genus was originally characterized only by the few characters leading to it in Foerster's key to his family Phygadeuontoidae, and no species was assigned to it. The first couplet in the key definitely excludes Brischke's two species from *Thysiotorus,* for they are described as having the wings short, and quite obviously would run not to *Thysiotorus* but to *Phyrtus,* and one wonders if the name *Physiotorus* was not a lapsus for *Phyrtus* on the part of Brischke rather than a printer's error in the spelling of *Thysiotorus.* In any event, it is obvious that neither of the two species referred to *Physiotorus* by Brischke can properly serve as genotype of *Thysiotorus.*

The next inclusion of a species in *Thysiotorus* was by Viereck,[3] who referred *Mesoleptus? peregrinus* Cresson to the genus. I have already shown[4] that this species can not be accepted as the genotype, since it disagrees with the original description of the genus.

In Foerster's key *Thysiotorus* is grouped with *Panargyrops* and *Apsilops* (as though their author considered them related) on three characters: Long, slender, basal joints of flagellum, silky-haired face, and long deep notaulices. By these same three characters with others, Thomson characterized his genus *Leptocryptus,*[5] including in it *claviger* Taschenberg, properly designated by Viereck as genotype of *Panargyrops* and of the synonymous

[2] U. S. Nat. Mus. Bull. 83: 145. 1914.
[3] Proc. U. S. Nat. Mus. 42: 645. 1912.
[4] *Ibid.* 58: 258, 260. 1920.
[5] Opuscula entomologica, fasc. 10: 963–966. 1884.

Leptocryptus. Also included in *Leptocryptus* is *L. lamina* Thomson, which agrees perfectly with the published description and also with Foerster's detailed unpublished description of *Thysiotorus*. I have already[4] referred *lamina* Thomson and *smithi* Cushman doubtfully and *Mesoleptus triangularis* Cresson positively[6] to *Thysiotorus*, and I am now convinced that they are properly to be referred to the genus. Viereck[7] apparently had no such doubt with regard to *smithi*, for he definitely referred it to *Thysiotorus*, thereby making it the first species properly so referred.

The following alterations to Viereck's genotype catalogue are therefore proposed:

Physiotorus Brischke (not *Thysiotorus* Foerster).
Schrift. Naturf. Ges. Danzig **7** (N.F.): 71. 1891. Two species.
Type.—*Hemiteles* (*Physiotorus*) *brevipennis* Brischke (by designation of Viereck, U. S. Nat. Mus. Bull. **83**: 116. 1914).

Thysiotorus (Foerster) Viereck.
Verh. Naturh. Ver. Preuss. Rheinlande **25**: 81. 1868. No species.
Can. Ent. **57**: 77. 1925. One species.
Type.—(*Thysiotorus* ? *smithi* Cushman) = (*Mesoleptus*) *Thysiotorus triangularis* (Cresson), new synonymy. By present designation; *Hemiteles* (*Physiotorus*) *brevipennis* Brischke (by designation of Viereck, U. S. Nat. Mus. Bull. **83**: 145. 1914) does not agree with original description and is therefore not available as genotype.

The above entries should replace the earlier emendations to the type catalogue proposed by me[4] under the headings "*Thysiotorus* Brischke, not Foerster" and "*Thysiotorus* Foerster."

The following is a free translation of Foerster's manuscript description:

THYSIOTORUS Foerster

Clypeus weakly separated from face, flat, rounded at apex and transversely impressed, without apical denticles, but slightly projecting medially; face and clypeus covered with long silky hair; clypeal foveae and malar space with much denser hairs, these hairs curved—not long, straight, and weak as those on the face and clypeus; teeth of mandible of equal length; first joint of flagellum longer than second; mesoscutum with notaulices deep and complete; propodeum with long hair, completely areolated; first abdominal segment slender, little broadened toward apex, fringed laterally by long erect hair, spiracles slightly behind middle; second segment with thyridia far from base, spiracles behind middle; nervellus not broken; second discoidal cell a little or distinctly broader at base than the brachial cell at apex; discocubitus broken; hind calcaria less than one-third as long as basitarsus; fifth tarsal joint somewhat shorter than third.

Following the description in Foerster's manuscript is a key to nine manuscript species.

Thysiotorus latifrons, n. sp.

Similar to *triangularis* (Cresson), but with smaller eyes, broader face, longer malar space, more shining propodeum, and open areolet.

[4] Proc. U. S. Nat. Mus. **74** (16): 58. 1927.
[7] Can. Ent. **57**: 77. 1925.

Female.—Length 5.5 mm, antenna 4 mm.

Head with dense silvery pubescence, longest on face and sides of frons; combined face and clypeus as broad as long; eyes very slightly convergent; clypeus convex, transversely impressed before the bidenticulate apex, foveae covered by tufts of long curved hairs; malar space two-thirds as long as basal width of mandible; temple convex, strongly receding, two-thirds as long (in dorsal view) as short diameter of eye; diameter of lateral ocellus longer than postocellar line and nearly as long as ocellocular line; antenna 26-jointed.

Thorax shining, with long silvery pubescence; pronotum laterally largely polished and glabrous, as is also a large area on mesopleuron embracing speculum and a deep, oblique impression; propodeum shining, especially medially, where it is virtually hairless, apical carina nearly at middle of dorsal length, areola large with costulae far before middle; areolet open at apex, the second intercubitus barely indicated.

Abdomen elongate fusiform, widest at apex of third segment; first tergite scarcely twice as broad at apex as at base, spiracles barely behind middle, postpetiole laterally striate; tergites 2 and 3 longitudinally striate, polished apically, polished areas longer medially; other tergites, except finely punctate base of 4, unsculptured; ovipositor sheath about as long as first segment.

Black; mandibles reddish; palpi, scape below, front and middle legs, tegulae, and small humeral angles of pronotum stramineous to whitish; tergites pale reddish stramineous apically, 2 to 4 triangularly so; front tarsus apically and middle tarsus except base black; hind coxa, trochanter, and femur brownish ferruginous to piceous, coxa and trochanter stramineous below; hind tibia fuscous, paler below; tarsus black, calcaria pale; wings hyaline, venation blackish, stigma pale at base.

Male.—More slender than female but otherwise very similar structurally; hind coxa and trochanter stramineous, hind femur somewhat paler; pale markings of abdomen larger, those of tergites 2–4 sometimes extending to base medially.

Host.—*Neodiprion tsugae* Middleton (probably secondary).

Type locality.—Sweet Home, Oreg.

Holotype, allotype, and *paratypes.*—U.S.N.M. no. 53346.

Paratypes.—Canadian National Collection; California Academy of Sciences.

Described from 50 females (including holotype) and 16 males (including allotype), all reared from cocoons of *Neodiprion tsugae* Middleton, undoubtedly as secondary parasites, partly at the type locality by R. L. Furniss, under Hopk. U. S. no. 31600G, and partly at the Northeastern Forest Insect Laboratory, New Haven, Conn., under no. 51–201–35, from cocoons of *N. tsugae* received from Sweet Home, Oreg.

Panargyrops areolaris, n. sp.

Closely related to *tibialis* Cushman, but generally stouter, with postpetiole nearly or quite twice as broad as petiole and second tergite much less than three times as long as basal width; clypeus nearly or quite as long as face is medially; propodeal areola very large, broader than long, with sides parallel; and ovipositor distinctly less than three-fourths as long as abdomen.

Female.—Length 6–8 mm (holotype 8 mm).

Head thick, occiput shallowly concave; temples hardly receding; diameter of lateral ocellus as long as postocellar line and half as long as ocellocular line; eyes parallel; face twice as broad as long, hardly longer medially than clypeus; malar space more than half as long as basal width of mandible; clypeal denticles distinct and rather widely separated; eyes somewhat bulging; antenna as long as abdomen, 29-jointed in holotype.

Thorax rather stout, much less than twice as long as deep, polished, very faintly punctate; pronotum not striate below, epomia distinct nearly to ventral angle; mesoscutum nearly circular, as broad as long; propodeal areola very large, slightly broader than long.

Abdomen slender, minutely punctate; postpetiole nearly twice as broad at apex as petiole, medially channeled; second tergite less than three times as long as basal width, third about as long as broad; ovipositor sheath little more than half as long as abdomen.

Black; pubescence with silvery reflection; scape below, mandibles, palpi, tegulae, and radices of wings white; humeral angle of pronotum pale reddish; legs reddish testaceous to ferruginous, hind leg darkest, front coxa and front and middle trochanters whitish, hind tibia mostly fuscous, its tarsus black, calcaria pale; abdomen with apical tergites very narrowly pale margined, venter whitish with piceous sternites.

Male.—Differs remarkably from female in both structure and color; eyes distinctly convergent below; face two-thirds as long as broad; malar space very short; abdomen very slender, postpetiole only a little broader than petiole, tergite 2 fully three times as long as basal width, its sides weakly divergent; tergite 3 much longer than broad; hind coxa and trochanter ventrally whitish; abdomen with a median pattern of reddish involving apex of tergite 1, apex or entire length of tergite 2, and entire lengths of 3 and 4, and broadening at apices of tergites 2–4 to embrace nearly or quite the entire width of the tergites, tergites 3–4 sometimes entirely reddish.

Host.—*Neodiprion tsugae* Middleton (probably secondary).

Type locality.—Sweet Home, Oreg.

Holotype, allotype, and *paratypes.*—U.S.N.M. No. 53347,

Paratypes.—Canadian National Collection; California Academy of Sciences.

Twenty-four females and 7 males, two of the females reared at the type locality by R. L. Furniss, September 16–17, 1935, under Hopk. no. 31660Q; the rest, including the holotype female and allotype male, reared from host cocoons from the same locality, at the Northeastern Forest Insect Laboratory, under no. 51–201–36–2 in Oct. 1936 and May and June 1937.

The antigeny in this species is very unusual—so far as the observation of the author goes, unique—for the genus. Also unusual is the frequent lack, especially in the male, of the second intercubital vein, resulting in an open areolet.

Delomerista diprionis, n. sp.

A stouter species than *novita* (Cresson), with the thorax nearly two-thirds as deep as long, the propodeal areola fully as broad as long, and the abdomen broader, with the second tergite not longer than its basal width. In *novita* the thorax is nearly twice as long as deep, the areola longer than broad,

and the second tergite longer than the basal width. In *diprionis* the ovipositor sheath is hardly half as long as the abdomen and the apex of the ovipositor is very bluntly pointed, whereas in *novita* the sheath is distinctly more than half as long as the abdomen and the ovipositor is acute at the apex.

Female.—(Holotype) Length 10 mm, antenna 8 mm, ovipositor sheath 3 mm.

Head polished, sparsely and weakly punctate, except on face, which is coarsely punctate and mat, in dorsal view with temples convexly receding, about two-thirds as long as short diameter of eye; face medially strongly convex; clypeus about twice as broad as medially long; malar space nearly half as long as basal width of mandible.

Thorax stout, nearly two-thirds as deep as long, polished, sparsely and minutely punctate; propodeum short, posterior face longer than dorsal face, basal lateral areas and areola polished and at most sparsely punctate, posterior face finely coriaceous and mat, other areas more coarsely punctate.

Legs stout, hind coxa a little longer than deep, femur about four times as long as deep, tibia distinctly shorter than combined lengths of femur and trochanter.

Abdomen minutely ruguloso-coriaceous, mat, first tergite more roughly sculptured; broad, second tergite as broad at base as long; ovipositor sheath barely half as long as abdomen; ovipositor in profile bluntly pointed.

Color, as in *novita*, black, with mandibles, malar space, palpi, humeral angle of pronotum, tegulae, radices of wings, and membranous margins of tergites 5–7 whitish; clypeus and occasionally facial orbits piceous; legs ferruginous; apex of front coxa, trochanter and femur anteriorly and apically, middle trochanter and femur apically, front and middle tibiae, except a basally incomplete piceous streak on the extensor surface of each, hind tibia at base and usually more or less below, and a narrow basal annulus on basitarsus whitish; front coxa piceous; front and middle tarsi fuscous; hind femur at apex, and hind tibia and tarsus except white markings, black; wings hyaline, venation black, stigma with a small white spot at base; apex of ovipositor sheath reddish.

Male.—Except for smaller size, more slender build, and shorter malar space, differs from female largely in greater extent of white, this including face, underside of scape, clypeus, entire front and middle coxae and trochanters and hind trochanter, and front and middle femora except posteriorly.

Host.—Various species of *Diprion* and *Neodiprion*.

Type locality.—Oakville, Ontario.

Holotype, allotype, and *paratypes.*—U.S.N.M. no. 19180.

Paratypes.—Canadian National Collection; Boston Society of Natural History; Connecticut Agricultural Experiment Station; Entomological Laboratory, Maine Forest Service, Augusta, Maine; California Academy of Sciences.

Described from 38 females and 27 males selected from several series reared from various species of the sawfly genera *Diprion* and *Neodiprion* and a few collected specimens as follows: 9 ♀ and 4 ♂, Oakville, Ontario, reared, evidently indoors, January 1–19, 1934, from *Diprion simile* (Hartig), including holotype and allotype: 3 ♀ and 6 ♂, New Haven, Conn., reared

April 29–May 21 from *D. simile* by M. P. Zappe; 1 ♀, Dublin, N. H., reared (indoors) January 15, 1938, from *D. polytonum* (Hartig) under N. E. Forest Insect Laboratory no. 11.203–37–22; 5 ♀ and 10 ♂, Sweet Home, Oreg., under N. E. For. Ins. Lab. no. 51–201, April 14–June 21, 1936, from *Neodiprion tsugae* Middleton; 4 ♀ and 3 ♂, Sweet Home, Oreg., June 29–July 19, 1935, also from *Neodiprion tsugae* Middleton, under Hopk. no. 31607 P; 2 ♀ and 1 ♂ from the same host, Queen Charlotte Island, British Columbia, April 6, 1931, and March 21 and April 26, 1932, G. R. Hopping; 8 ♀ and 2 ♂, Lincoln, Maine, May 26–June 5, 1932, from *Neodiprion* sp. on *Pinus rigida* and *Pinus resinosa;* 1 ♀, Mont. Laurier, Quebec, December 6, 1929, *Neodiprion* sp. on *Pinus banksiana*, M. Dunn; 1 ♀, Pictured Rocks, Munising, Mich., August 2, 1936, C. W. Sabrosky; 3 ♀, Cranmoor, Wis., June 25, 1910, C. W. Hooker; 1 ♀, Pullman, Wash., August 11, 1896, C. V. Piper; 1 ♂, Moscow, Idaho, May 30, 1912, J. M. Aldrich.

There is considerable variation in size, partly associated with size of the host, specimens from *Diprion simile* averaging largest and those from *Neodiprion tsugae* smallest, females ranging in length from 5 to 11 mm, and males from 6 to 10 mm. The comparative width of the abdomen, especially in the female, and the strength of the propodeal carinae also exhibit considerable variation.

Genus **Lamachus** Foerster

To this genus are here assigned those species, otherwise very close to *Mesoleius* both morphologically and biologically, that possess the alar areolet and have the clypeus without a median elevation, but nearly flat, at most shallowly emarginate apically and with a narrow reflexed margin. All the species here treated differ from the genotype, *lophyrorum* (Hartig), by having the speculum more or less polished. Like the genotype, all are parasitic in larvae of sawflies of the subfamily Diprioninae.

The following North American species are referable to the genus as here limited:

Lamachus lophyri (Ashmead), n. comb.

Neoeryma lophyri Ashmead, Proc. Ent. Soc. Washington **4**: 169. 1897.

Lamachus virginianus (Rohwer), n. comb.

Lagarotis virginianus Rohwer, Proc. U. S. Nat. Mus. **49**: 218. 1915.

Lamachus ruficornis (Cushman), n. comb.

Labrossyta ruficoxalis Cushman, Proc. Ent. Soc. Washington **21**: 118. 1919.

Lamachus contortionis Davis

Lamachus ? contortionis Davis, Trans. Amer. Ent. Soc. **24**: 284. 1897.
Lagarotis diprioni Rohwer, Proc. U. S. Nat. Mus. **49**: 215. 1915. New synonymy.

Lamachus tsugae, n. sp.

A black species with unusually few and small pale markings.

Female.—Length (holotype) 6 mm, antenna 5.5 mm.

Head mat, alutaceous, only temples shining; temples strongly convex; postocellar line little longer than ocellocular line and hardly a half longer than diameter of an ocellus; face sparsely and finely punctate, nearly as broad as eye is long; eyes parallel, very faintly emarginate opposite antennae; clypeus fully half as long as interfoveal line; malar space much less than half as long as basal width of mandible; antenna 35-jointed.

Thorax stout, hardly a half longer than deep, finely alutaceous and sparsely punctate laterally and ventrally, subpolished and sparsely punctate dorsally, speculum polished; notaulices shallow but distinct to a flattened area on disk of mesoscutum; propodeum finely alutaceous, shining basally, mat apically, with faintly indicated lateral carinae, but without median and apical carinae; legs rather slender, hind femur nearly six times as long as deep.

Abdomen stout, tergite 1 distinctly broader at apex than distance from spiracle to apex and more than half as broad basally as apically, tergite 2 broader at base than long; abdomen alutaceous, mat, impunctate, compressed at apex.

Black, with the following markings yellow: Triangular spots in lower facial orbits and occasionally more or less of middle area of face, clypeus, cheeks narrowly, mouthparts, collar narrowly and more or less of lower anterior margin and humeral angle of pronotum, sometimes small spots at origins of notaulices, usually very narrow margins of tergites, and ventral plica; antenna black, faintly reddish below; scutellum and postscutellum sometimes piceous and rarely yellowish medially; legs ferruginous, front and middle coxae and trochanters usually more or less stramineous anteriorly, hind knee, apical third or more of tibia, and entire tarsus black, tibia basally white; wings hyaline, venation black, stigma slightly paler.

Male.—More slender than female but otherwise very similar structurally; face yellow for its entire width and nearly up to antennal foramina, upper margin of yellow made uneven by three points of black extending into it from above; prepectus medially yellow and sometimes one or more streaks of yellow extend backward from it on sternum and lower part of pleurum.

Host.—*Neodiprion tsugae* Middleton.

Type locality.—Sweet Home, Oreg.

Holotype, allotype, and *paratypes.*—U.S.N.M. no. 53348.

Paratypes.—Canadian National Collection; California Academy of Sciences.

Described from 19 females and 7 males, all from cocoons of the host collected by R. L. Furniss at the type locality but mostly reared at the Northeastern Forest Insect Laboratory under no. 51.201.36.2. A few were reared by the collector under Hopkins U. S. no. 31607T.

Lamachus oregon, n. sp.

Similar to *ruficoxalis* (Cushman), but with entire face, broad frontal orbits, mesosternum largely, and front and middle coxae and trochanters yellow.

Female.—Length 7.0 mm, antennae (broken).

Head alutaceous, mat, temples somewhat shining, moderately convex and receding; postocellar line and diameter of an ocellus equal, slightly shorter than ocellocular line; face medially sparsely punctate, hardly as broad as eye is long; eyes parallel, faintly emarginate; clypeus half as long as interfoveal line; malar space nearly half as long as basal width of mandible.

Thorax hardly a half longer than deep, finely alutaceous and weakly shining laterally, polished dorsally, speculum polished, mesoscutum very finely, pleura more coarsely, punctate; notaulices faint; propodeum finely, granularly mat medially and apically, basal lateral areas somewhat shining and shallowly punctate; only lateral carinae distinct; legs moderately stout, hind femur less than six times as long as deep.

Abdomen rather slender; first tergite less than half as broad basally as apically and hardly broader at apex than distance from spiracles to apex, with a median sulcus on postpetiole flanked by prominent, posteriorly divergent ridges; tergite 2 hardly as broad at base as long; abdomen alutaceous and almost mat, impunctate, compressed apically.

Head and thorax black and yellow, abdomen and legs largely ferruginous; yellow are the face, broad frontal orbits, cheeks and malar space, clypeus, mandibles, palpi, underside of scape and pedicel, anterior margin and humeral angles of pronotum, large cuneiform spots on mesoscutum, scutellum largely, postscutellum, tegulae, subalar tubercles, posterior margin of prepectus, mesosternum largely, mesometapleural suture, front and middle coxae and trochanters and the extensor surfaces of their tibiae, basal half of hind tibia, and ventral plica including hypopygium; tergite 1 black, with broad apical margin extending laterally to include spiracles ferruginous, median carinae near base yellowish; apical half of hind tibia and its tarsus black; flagellum black above, reddish below; wings hyaline, venation black.

Male.—Similar to female, but malar space shorter, postocellar line longer than ocellocular line or than diameter of ocellus, the latter two equal, abdomen more slender; yellow markings, especially on thorax, more extensive, with pronotum largely, mesosternum, prepectus and lower half or more of mesopleuron, metapleuron largely, and sometimes part of pleural area of propodeum yellow; mesoscutal markings frequently extending backward along notaulices and meeting on disk; black of thorax and abdomen frequently more or less, and sometimes entirely, replaced by ferruginous. Antenna with 35–36 joints.

Host.—*Neodiprion tsugae* Middleton.

Type locality.—Sweet Home, Oreg.

Holotype, allotype, and *paratypes.*—U.S.N.M. no. 53349.

Paratypes.—Canadian National Collection; California Academy of Sciences.

One female and 16 males, all reared at the Northeastern Forest Insect Laboratory from cocoons of the host collected at the type locality, under nos. 51.201.36.2 (June 14, 1937) and 51.201.35 (June 17, 1936). The holotype female and allotype male are selected from the first-mentioned series.

The males vary greatly in color, as stated above, and from 4 to 8 mm in length.

PROCEEDINGS OF THE ACADEMY AND AFFILIATED SOCIETIES

THE ACADEMY

NEW MEMBERS ELECTED

The following were recently elected to active resident membership in the Academy:

HARRY G. BARBER, associate entomologist, U. S. Bureau of Entomology and Plant Quarantine, in recognition of his work on the taxonomy and biology of the Hemiptera.

LUTHER A. BLACK, professor of bacteriology, University of Maryland, in recognition of his researches in dairy and food bacteriology, especially the physiology of bacteria and thermophilic bacteria.

JUAN BREWER DEMAREE, senior pathologist, U. S. Bureau of Plant Industry, in recognition of his contributions on the diseases of nut trees and small fruits.

WILLIAM W. DIEHL, associate mycologist, U. S. Bureau of Plant Industry, in recognition of his work on the taxonomy of fungi, particularly the Ascomycetes.

ADOLPH EICHHORN, superintendent in charge, Animal Disease Station, U. S. Bureau of Animal Industry, Beltsville, Md., in recognition of his contributions to veterinary science and comparative pathology.

CHESTER W. EMMONS, senior mycologist, National Institute of Health, in recognition of his contributions to systematic mycology and in particular his researches on fungi pathogenic to man.

IRA N. GABRIELSON, chief, U. S. Bureau of Biological Survey, in recognition of his accomplishments in biological research, especially his work on the distribution and economic importance of birds and rodents.

ANNA E. JENKINS, associate mycologist, U. S. Bureau of Plant Industry, in recognition of her contributions to taxonomic mycology and in particular her researches on the orders Myriangiales and Exoascales.

EDMUND B. LAMBERT, pathologist, U. S. Bureau of Plant Industry, in recognition of his work on the culture and diseases of mushrooms.

HANS LINEWEAVER, chemist, U. S. Bureau of Agricultural Chemistry and Engineering, in recognition of his work in biochemistry.

JOHN H. MARTIN, senior agronomist, U. S. Bureau of Plant Industry, in recognition of his investigations in the genetics of sorghum.

JOHN B. MERTIE, JR., senior geologist, U. S. Geological Survey, in recognition of his work on the geology of Alaska.

MARK L. NICHOLS, acting chief, Division of Research, U. S. Soil Conservation Service, in recognition of his researches in soil physics relating to tillage machinery and his contributions to improved soil conservation practice.

DOROTHY NICKERSON, color technologist, U. S. Bureau of Agricultural Economics, in recognition of her contributions to optics, particularly to the colorimetric grading of agricultural products.

FRANCIS WILTON REICHELDERFER, chief, U. S. Weather Bureau, in recognition of his work on the development of aeronautical meteorology and air mass analysis.

JOHN A. SCHERRER, chemist, National Bureau of Standards, in recognition of his work on the development of methods in the chemical analysis of nonferrous materials.

JOSEPH F. SILER, director, Army Medical School, in recognition of his achievements in the fields of sanitation and hygiene, and particularly for his work on the transmission of dengue fever and the prevention of typhoid fever.

MAURICE I. SMITH, principal pharmacologist, National Institute of Health, in recognition of his researches in drug and vitamin standardization, particularly his contributions on the pharmacology of phenol esters and the toxicology of selenium.

EARLE O. WHITTIER, senior chemist, U. S. Bureau of Dairy Industry, in recognition of his researches on the chemistry of milk, particularly its buffer action.

The following were recently elected to active nonresident membership in the Academy:

WALTER J. YOUNG, head of the Department of Psychology and Philosophy, Mary Washington College, Fredericksburg, Va., in recognition of his researches in psychology, philosophy, and education.

The following were recently elected to honorary membership in the Academy:

GEORGES PERRIER, Major General Retired, formerly chief, Division of Geodesy of the French Army, Paris, France, in recognition of his contributions in the field of geodesy.

PEDRO SANCHEZ, director, Pan American Institute of Geography and History, Tacubya, D. F., Mexico, in recognition of his cooperation with the United States Government in the field of geodesy.

EDWARD RHODES STITT, Rear Admiral, U. S. Navy (retired), Washington, D. C., in recognition of his achievements in the fields of bacteriology and animal parasitology and particularly his contributions to tropical medicine.